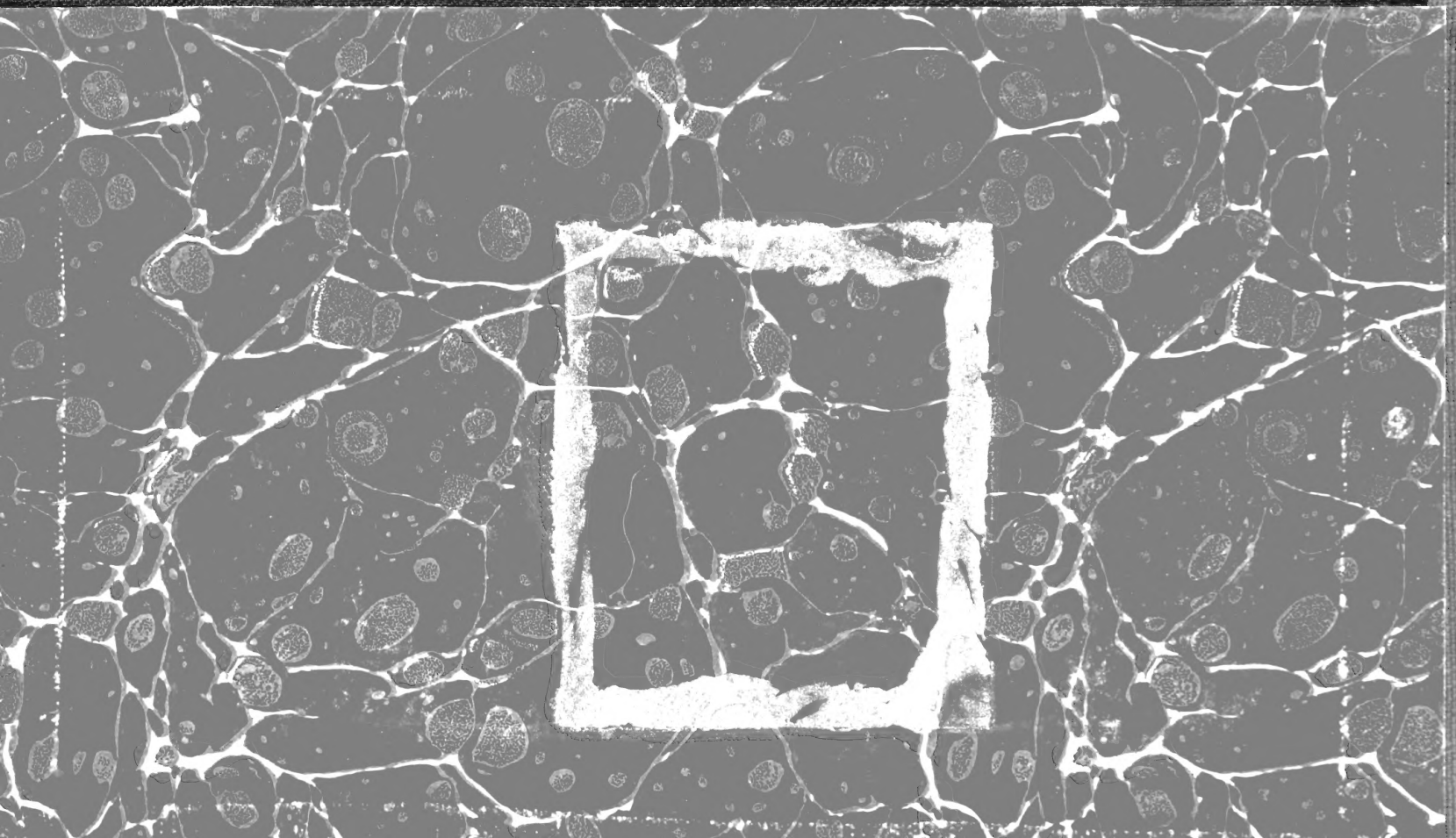

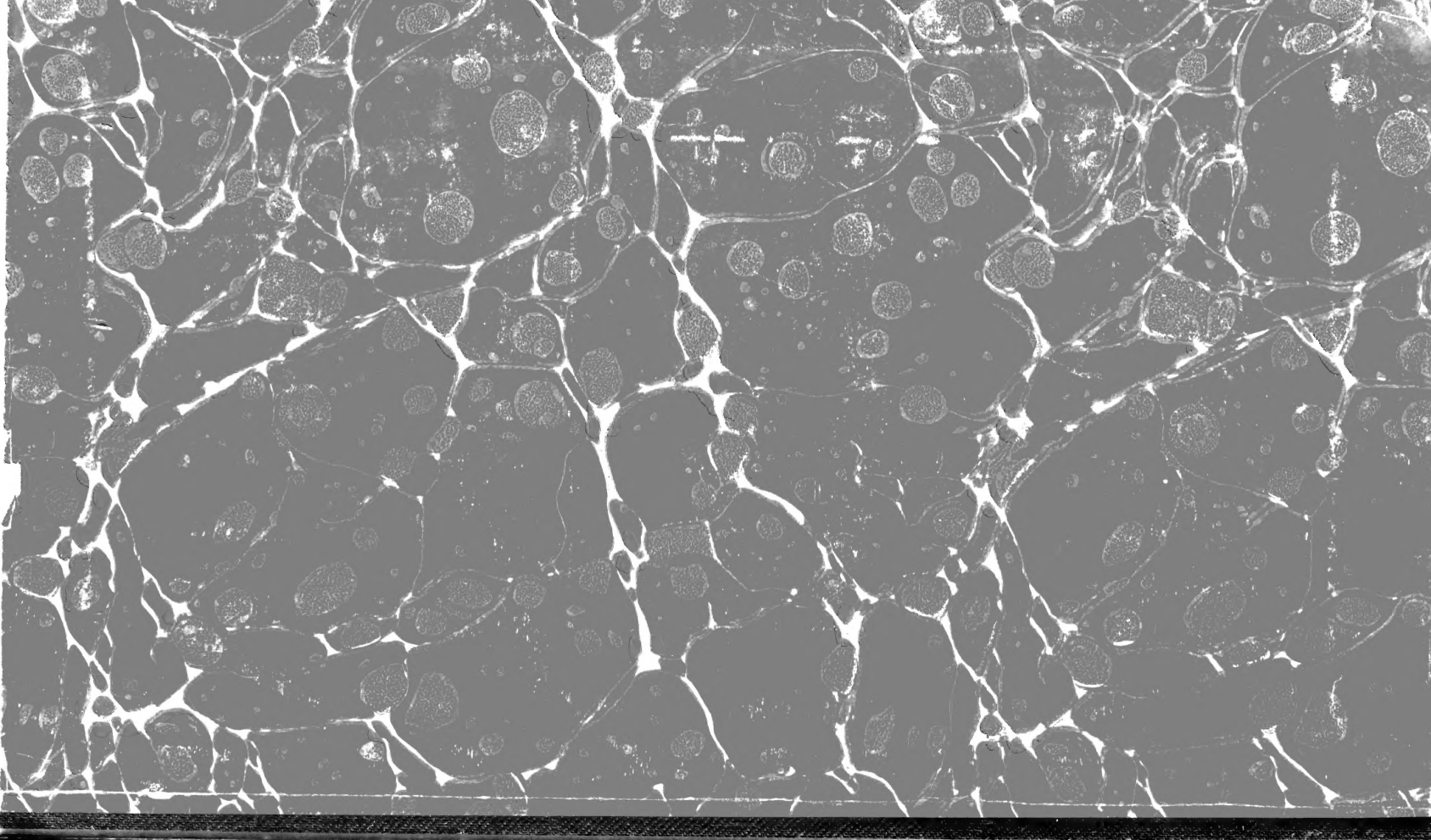

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In Cooperation with the
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Washington, D. C. ▼ February 12, 1925

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By

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THE HARD RED WINTER WHEATS

Hard red winter wheat, introduced into America from Russia about 50 years ago, is now the leading commercial class of wheat in the United States. The introduction of hard red winter wheat resulted in the extension of wheat growing into areas where without it successful farming would have been much more difficult, if not impossible. The growing of this wheat also resulted in the development of a large milling industry in the Central and Southwestern States.

Many of the failures of pioneer farmers in the drier sections of the western United States were due to the attempt to grow unadapted crops. The introduction of hard red winter wheat into certain of these localities which had been abandoned by the earliest settlers later made possible a permanent wheat-growing industry. Hard red winter wheat is now the principal crop in many sections of limited rainfall, including much of Kansas and Nebraska, western Oklahoma, northeastern Colorado, central Montana, and the drier portions of the Columbia Basin of Oregon and Washington. In these areas farming was not practiced or was exceedingly hazardous before this class of wheat was grown. It is also the most productive class of wheat of other sections, including the Panhandle district of Texas and the dry lands of Utah and southeastern Idaho. East of the principal

producing section hard red winter wheat also is important in Iowa and central Illinois. Varieties of this wheat are practically the only winter wheats which are successfully grown in the cold northern States of Wisconsin, Minnesota, North Dakota, South Dakota, Wyoming, and eastern Montana.

The first hard red winter wheat apparently was introduced into Kansas from Russia in 1873. Other records indicate that it may have been introduced into Iowa from Illinois as early as 1870 by Mennonite immigrants from Russia who first settled in Illinois. It did not become generally grown until about 20 or 25 years after its introduction. During the past 25 years, however, the growing of hard red winter wheat has increased rapidly. In 1919 this class of wheat was grown on more than 21,000,000 acres, which comprised nearly one-third of the total wheat acreage in the United States. The distribution of hard red winter wheat in 1919 is shown on the map in Figure 1.

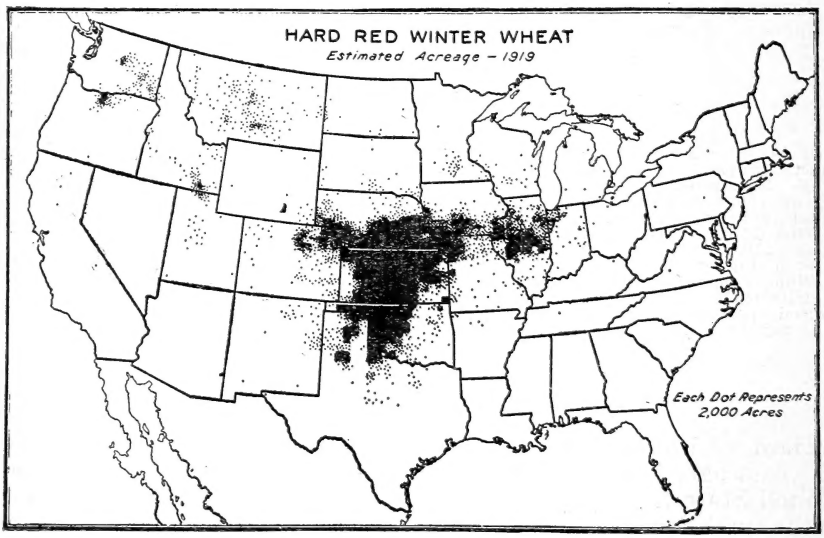

FIG. 1.—Outline map of the United States, showing the distribution of the acreage of hard red winter wheat in 1919. Estimated area, 21,677,900 acres. Each dot represents 2,000 acres

Hard red winter wheat was not received with favor by millers for many years. The development of the steel roller mill and the purifier, however, made possible the manufacture of flour of high quality from this wheat. The price of hard red winter wheat at the terminal markets always was less than that of soft red winter wheat until about 1910, since which time the hard wheat usually has been higher in price.

VARIETIES COMPARED

The hard red winter wheats consist of two distinct morphological groups. That properly called the Crimean group consists of a number of nearly identical varieties, of which Turkey is the best known. There are several additional varieties and selections which differ in yield, disease resistance, or minor taxonomic characters from the Turkey variety. The wheats of the Crimean group have rather tapering, inclined, awned spikes; glabrous white or yellow glumes;

and midsized slender dark-red kernels. The stems are slender and weak and subject to lodging under humid conditions.

The Alton variety is distinct from the wheats of the Crimean group chiefly in being awnless and in having shorter and softer kernels.

In addition to the hard red winter wheats a few other winter varieties belonging to the soft red winter and white wheat classes are being grown in the western United States. Most of these were included in the experiments here reported and their performance is compared with that of the hard red varieties.

Following is a descriptive key for the distinct varieties of hard red winter wheats and also for the varieties of soft red winter wheats, common white wheats, and club wheats, from which comparative data are reported here.

KEY TO THE VARIETIES

HARD RED WINTER VARIETIES

Spike awned; glumes glabrous, white or yellow; kernels red--(Crimean group).
- Kernels hard.
  - Beaks 2 to 8 millimeters long----Turkey (Alberta Red, Argentine, Armavir, Bosnian, Bulgarian, Crimean, Defiance, Eversole, Improved Turkey, Kharkof, Malakof, Pioneer Turkey, Red Russian, Red Winter, Reliable, Rieti, Romanella, Rumanian, Serbian, Tauranian, Theiss, Turkey Red, and Ulta), Altara, Karmont, Montana No. 36, Nebraska No. 6, Nebraska No. 60, "Station Red."
  - Beaks 3 to 25 millimeters long.
    - Rust resistant----Kanred (P–1066, P–1068).
    - Rust susceptible----Bacska, Beloglina.
- Kernels semihard to hard.
  - Glumes white to yellowish.
    - Beaks 1 to 3 millimeters long.
      - Plant midseason----Minturki.
      - Plant late----Hussar.
    - Beaks 2 to 8 millimeters long----Pesterboden (Banat, Budapest, Hungarian, Torgova, Weissenberg).
  - Glumes often black striped----Blackhull.

Spike awnless; glumes glabrous, white or yellow; kernels red----(Alton group) Alton.

SOFT RED WINTER VARIETIES

Spike awned.
- Glumes glabrous.
  - Glumes white or yellow----Fulcaster (Dietz), Jejar, Mammoth Red, Nebraska No. 28.
  - Glumes brown or red----Mediterranean, Diehl-Mediterranean.
- Glumes pubescent, brown or red----Penquite (Japanese Velvet Chaff).

Spike awnless.
- Glumes glabrous.
  - Glumes white or yellow----Buffum No. 17, Fultz, Harvest Queen, Lofthouse, Minhardi, Purplestraw, Zimmerman.
  - Glumes brown or red----Currell, Odessa.
- Glumes pubescent, white or yellow----Jones Fife, Triplet.

COMMON WHITE VARIETIES

Spike awnless; glumes glabrous.
- Glumes white or yellow----Prohibition, Winter Bluestem.
- Glumes brown or red----Goldcoin (Fortyfold), Kofod.

CLUB VARIETY

Spike awnless; glumes glabrous, white or yellow----Hybrid 128.

ORIGIN OF THE VARIETIES

The sources and origin of seed of the varieties are shown in brief tabular form in Table 1.

TABLE 1.—*Name under which obtained, Office of Cereal Investigations number, source of seed, year obtained, and the original source of the varieties and strains of winter wheat grown at 15 experiment stations in the Great Plains and Great Basin areas during the 17-year period from 1906 to 1922, inclusive*

Class and variety	C. I. No.	Where obtained	Year obtained	Original source or origin
Hard red winter:				
Alberta Red	2979	Calgary, Alberta, Canada	1907	Russia.
Altara (Kansas No. 2048).	5797	Manhattan, Kans.	1917	Manhattan, Kans.
Alton	1438	Altonau, Taurida, Russia	1900	Russia.
Argentine	1569	Marseille, France	1900	
Armavir	1355	Armavir, Kuban, Russia	1899	Do.
Armavir (selection)	1355–2–2			
Bacska	1562	Budapest, Hungary	1900	Hungary.
Banat	1560	do	1900	Do.
Beloglina	1543	Rostov-on-Don, Russia	1900	Russia.
Do	1544	do	1900	Do.
Do	1549	Volo, Greece	1901	Greece.
Do	1667	Rostov-on-Don, Russia	1901	Russia.
Do	2239	Byeloglinskaya, Russia	1903	Do.
Blackhull	6251	Manhattan, Kans	1919	Sedgwick, Kans.
Bosnian	1691		1900	Bosnia.
Budapest	1739	Grand Rapids, Mich	1900	Hungary.
Bulgarian	2048	Bulgaria	1901	Bulgaria.
Crimean	1432	Kurman-Kemelchi, Russia	1900	Russia.
Do	1433	Berdiansk, Russia	1900	Do.
Do	1435	Ambracievka, Russia	1900	Do.
Do	1436	Kurman-Kemelchi, Russia	1900	Do.
Do	1437	Altonau, Taurida, Russia	1900	Do.
Do	1559	Crimea	1901	Do.
Defiance	6214	Manhattan, Kans	1903	Selected from a so-called Defiance wheat obtained from Iowa Seed Co.
Eversole	3011	Marquette, Kans	1906	Smoky Valley, Kans.
Hungarian	2034	Hungary	1901	Hungary.
Do	2042	do	1901	Do.
Kanred	5146	Manhattan, Kans	1910	Selected from Crimean, C. I. No. 1435.
Karmont	6700	Moccasin, Mont	1911	Selected from Kharkof, C. I. No. 1583.
Kharkof	1442	Kharkof, Russia	1900	Russia.
Kharkof (Selection No. 6P2).	----	Akron, Colo	1909	Selected from Kharkof, C. I. No. 1442.
Kharkof (Selection No. 12).	----	Moro, Oreg	1912	Do.
Kharkof	1583	Kharkof, Russia	1900	Russia.
Do	2193	do	1901	Do.
Do	2208	do	1902	Do.
Kharkof (Selection No. 6P4).	4207	Akron, Colo	1909	Selected from Kharkof, C. I. No. 1442.
Kharkof	5293	White Deer, Tex	1916	Kansas.
Kharkof (Montana No. 36).	5549	Bozeman, Mont	1917	Selected from Kharkof, C. I. No. 1583.
Kharkof (Hays No. 2).	6686	Hays, Kans	1911	Selected from Kharkof, C. I. No. 2193.
Malakof	2908	Shenandoah, Iowa	1905	Russia.
Minturki	6155	St. Paul, Minn	1918	Hybrid between Turkey and Odessa.
Nebraska No. 6	6249	Lincoln, Nebr	1918	Selected from Turkey.
Nebraska No. 60	6250	do	1918	Do.
P–1066	5879	Manhattan, Kans	1917	Selected from Crimean.
P–1068	5880	do	1917	Do.
Pesterboden	1564	Budapest, Hungary	1900	Hungary.
Red Russian	1532	Odessa, Russia	1900	Russia.
Red Winter	6213	Manhattan, Kans	1918	Obtained by the Kansas station from Iowa in 1900.
Reliable	3699	Minneapolis, Minn	1909	Obtained from Northrup, King & Co.
Rieti	2942	Italy	1906	Italy.
Rumanian	1656	Paris, France	1900	Rumania.
Do	1658	do	1900	Do.
Do	1562	do	1900	Do.
Serbian	1676	Serbia	1900	Serbia.
Serbian (Selection No.4–1–10).	1728	do	1900	Do.
"Station Red"	6467	Pullman, Wash	1917	Hybrid, involving Turkey, Jones Fife, and Pacific Bluestem.

TABLE 1.—*Name under which obtained, Office of Cereal Investigations number, source of seed, year obtained, and the original source of the varieties and strains of winter wheat grown at 15 experiment stations in the Great Plains and Great Basin areas during the 17-year period from 1906 to 1922, inclusive*—Continued

Class and variety	C. I. No.	Where obtained	Year obtained	Original source or origin
Tauranian	6202	Salina, Kans	1916	Russia.
Theiss	1561	Budapest, Hungary	1900	Hungary.
Torgova	1539	Tsaritsyn, Russia	1900	Russia.
Turkey	1558	Halstead, Kans	1901	Do.
Do	1571	British Columbia	1901	Kansas.
Do	1756	Columbia, Mo	1900	
Do	1783	Yukon, Okla	1901	
Do	1784	do	1901	
Do	2223	Manhattan, Kans	1902	
Do	2943	Amarillo, Tex	1906	
Do	2998	Nephi, Utah	1907	
Do	3055	Highmore, S. Dak	1908	Iowa.
Do	3084	Fargo, N. Dak	1908	
Do	3689	Brookings, S. Dak	1901	Mitchell, S. Dak.
Do	4061	Aberdeen, Idaho	1913	
Do	4429	Moro, Oreg	1915	
Turkey (Improved)	5592	Manhattan, Kans	1906	
Turkey (Washington No. 326).	6175	Pullman, Wash	1916	Lincoln, Nebr.
Turkey (Kansas No. 1664).	6472	Manhattan, Kans	1919	
Turkey (Renner)				
Turkey (Blender)				
Turkey (Nygard)				
Turkey (Pioneer)	6613	P. J. Jennings, McCracken, Kans.	1917	
Turkey (Grafton)	3696	Grafton, N. Dak	1908	
Ulta	1439	North Caucasus, Russia	1900	Russia.
Weissenberg	1563	Budapest, Hungary	1900	Hungary.
Soft red winter:				
Buffum No. 17	3330	Worland, Wyo	1911	Selected from Turkey.
Currell	2906	Halstead, Kans	1902	Virginia.
Diehl-Mediterranean.	1395	East Lansing, Mich	1899	New York.
Dietz				
Fulcaster				
Fultz	6215	Manhattan, Kans	1918	Pennsylvania.
Harvest Queen	6199	do	1918	Kansas.
Japanese	1787	Paris, France	1900	Japan.
Japanese Square-head.	1788–1	do	1900	Do.
Jejar	2092	Albacete, Spain	1901	Spain.
Jones Fife	4468	Lind, Wash	1915	New York.
Jones Fife (Super)	5544	Santa Rosa, Calif	1917	Do.
Jones Fife	6177	Lind, Wash	1918	Do.
Lofthouse	3275	Nephi, Utah	1904	Utah.
Mammoth Red	2902	Dallas, Tex	1905	Texas.
Mediterranean	2900–1	Channing, Tex	1905	Do.
Do	2900–2	do	1905	Do.
Do	2901	Wichita Falls, Tex	1905	Do.
Minhardi	5149	St. Paul, Minn	1916	Hybrid between Turkey and Odessa.
Nebraska No. 28	5147	Lincoln, Nebr	1915	Hybrid between Turkey and Big Frame.
Odessa	3274	Nephi, Utah	1904	Russia.
Purplestraw	1915	Georgia	1900	
Penquite (Japanese Velvet Chaff).	1757	Paris, France	1900	Japan.
Triplet	5408	Pullman, Wash	1916	Hybrid, involving Turkey. Jones Fife, and Little Club.
Zimmerman	2907	Manhattan, Kans	1904	Maryland.
White wheat:				
Genesee Giant				New York.
Goldcoin (Forty-fold).	2996	Nephi, Utah	1907	Do.
Do	4156	Moro, Oreg	1912	Do.
Do	5290	Union, Oreg	1915	Union, Oreg.
Do	6176	Lind, Wash	1918	Pullman, Wash.
Kofod	2997	Nephi, Utah	1907	Utah.
Prohibition	4068	Moro, Oreg	1911	Oregon.
Winter Bluestem	5409	Pullman, Wash	1916	Hybrid between Turkey and Pacific Bluestem.
Club wheat:				
Hybrid 128	4326	do	1914	Hybrid between Jones Fife and Little Club.
Do	4512	do	1915	Do.

Many of the original introduced lots of hard red winter wheat are identical in all characters, but a few original varieties and some of the selected strains differ slightly in physiological or morphological characters. The principal variety, Turkey, has been introduced and distributed under many names. The most authentic history of the introduction of Turkey wheat traces to the immigration of German Mennonites from Russia to Kansas in 1873. These settlers brought small quantities of Turkey wheat for seed. Other lots of this wheat were introduced about this time and later into Nebraska, Kansas, and other States. The United States Department of Agriculture introduced large quantities of Crimean, Kharkof, and Turkey wheat about 1900. Experiment stations and farmers have increased and distributed selections of these wheats. The original introductions, locally adapted strains or selections of these, and hybrids between Turkey and other varieties now make up the list of hard red winter wheats considered here.

Of the soft red winter wheats grown in these experiments one variety, Buffum No. 17, was selected from Turkey wheat and apparently is a natural field hybrid. Three other varieties, Minhardi, Nebraska No. 28, and Triplet, are the result of artificial hybridization between Turkey and soft red winter varieties. One variety of white wheat, Winter Bluestem, is the result of a hybrid between Turkey and Pacific Bluestem. The remaining varieties of soft red winter wheat, white wheat, and club wheat are grown in comparison with the hard red winter varieties in order to compare their local adaptations.

TABLE 2.—*Altitude, normal or average precipitation, and soil type at 11 stations in the northern half of the Great Plains area and 4 stations in the Great Basin area*

Location of station	Altitude	Precipitation		Type of soil
		Normal or average	Length of record	
Great Plains area:	*Feet*	*Inches*	*Years*	
Amarillo, Tex.	3,676	20.81	28	Chocolate clay loam.
Hays, Kans.	2,000	22.96	50	Silty clay loam.
Akron, Colo.	4,560	18.79	18	Sandy loam.
Archer, Wyo.	6,027	13.99	[1] 50	Medium sandy loam with some gravel.
Sheridan, Wyo.	3,800	14.72	23	Dark clay loam.
Newell, S. Dak.	2,900	14.31	12	Clay (gumbo) with shale subsoil.
Highmore, S. Dak.	1,890	16.75	26	Glacial clay loam.
Dickinson, N. Dak.	2,453	15.29	31	Fine sandy loam to clay loam.
Williston, N. Dak.	1,875	15.07	40	Fine sandy loam.
Moccasin, Mont.	4,228	16.51	[2] 25	Dark clay loam, gravelly subsoil.
Great Basin area:				
Nephi, Utah	6,000	13.27	22	Clay loam.
Aberdeen, Idaho	4,400	9.33	11	Sandy clay loam.
Burns, Oreg.	4,100	7.49	6	Silt loam to fine sandy loam.
Moro, Oreg.	1,800	11.46	18	Silt loam.
Lind, Wash.	1,630	7.56	4	Fine sandy silt loam.

[1] Observations made at Cheyenne, Wyo., during part of the period.
[2] Observations made at Utica, Mont., during part of the period.

LOCATION OF THE EXPERIMENTS

The experiments here reported were conducted at 15 agricultural experiment stations [1] located in two distinct areas in the western United States, i. e., the Great Plains area and the Great Basin or Intermountain area. The locations of these experiment stations are

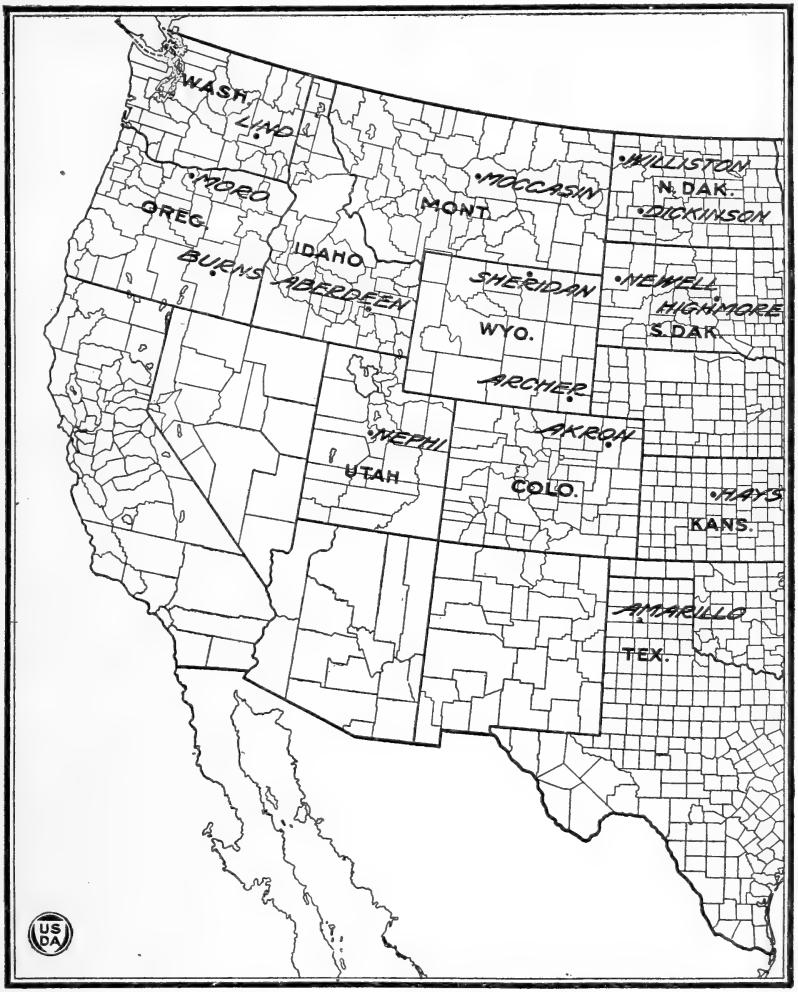

FIG. 2.—Outline map of the western half of the United States, showing the location of the 15 field stations from which the results of experiments with winter wheat are reported in this bulletin

shown on the accompanying map (fig. 2). Both of these areas are characterized by relatively low precipitation, high wind movement,

[1] The men who have had charge of the cereal experiments at the various stations during the period of these investigations are as follows: *Texas.*—Amarillo, A. H. Leidigh and J. F. Ross. *Kansas.*—Hays, F. A. Kiene, jr., and A. F. Swanson. *Colorado.*—Akron, W. G. Shelley, Clyde McKee, C. H. Clark, G. A. McMurdo, and F. A. Coffman. *Wyoming.*—Sheridan, L. D. Willey and R. S. Towle; Archer, J. W. Jones, V. H. Florell, and A. L. Nelson. *South Dakota.*—Highmore, M. J. Champlin, J. D. Morrison, and E. S. McFadden; Newell, S. C. Salmon and J. H. Martin. *North Dakota.*—Williston, F. R. Babcock; Dickinson, J. A. Clark and R. W. Smith. *Montana.*—Moccasin, E. L. Adams, N. C. Donaldson, P. V. Cardon, and R. W. May. *Utah.*—Nephi, F. D. Farrell, P. V. Cardon, A. D. Ellison, J. W. Jones, and A. F. Bracken. *Idaho.*—Aberdeen, L. C. Aicher. *Oregon.*—Moro, H. J. C. Umberger and D. E. Stephens; Burns, L. R. Breithaupt. *Washington.*—Lind, M. A. McCall.

and cold winter temperatures, but they differ markedly in the distribution of the precipitation. In the Great Plains area most of the precipitation falls in the spring and summer months, covering the chief growing period, while in the Great Basin area most of the precipitation occurs during the winter months, when evaporation is low and plant growth is slow, so that more moisture is saved for the use of the crop. The average annual precipitation and the length of the record, the altitude, and general soil type are shown in Table 2 for each of the 15 experiment stations.

GREAT PLAINS AREA

The Great Plains area extends from southern Texas northward into Canada and from about the ninety-eighth meridian westward to the Rocky Mountains. The elevation ranges from 1,500 to more than 6,000 feet.

The climate is semiarid, the average annual precipitation varying from 14 inches in the northern and western portions to 25 inches in the southern and eastern portions. In general, the evaporation varies with the precipitation in this area, being highest in the south and lowest in the high elevations of the north and west. Thus the higher precipitation in the southern portion is of little advantage.

Unfavorable climatic conditions, together with some injury from bunt (stinking smut), stem and leaf rusts, insects, and rodents, tend to keep the yields of winter wheat in the Great Plains area rather low.

High winds during the fall and winter frequently cause soil drifting and consequent injury to or loss of the wheat crop. Hot summer winds often cause premature ripening or deadening of the wheat plants, resulting in shrunken kernels, lowered yields, and lowered bushel weight of the grain. Low winter temperatures, especially in the more northern States and at the higher altitudes in the western portion of the Great Plains, frequently cause winterkilling of the fall-sown wheat.

The chief limiting factor in wheat production is deficient moisture. The yields usually are largely dependent upon seasonal precipitation and the supply of soil moisture. Often the soil is so dry and precipitation so slight that the wheat emerges very slowly after sowing and sometimes does not come up until the following spring.

GREAT BASIN AREA

The Great Basin area consists largely of elevated valleys and plateaus interspersed with mountain ranges. The average annual precipitation is less than in the Great Plains area, but successful wheat growing in the Great Basin is possible with less precipitation than in other parts of the United States. Here, as in the Great Plains, precipitation is the chief limiting factor in wheat production. Summer fallowing in preparation for winter wheat is commonly practiced, largely to conserve moisture. Winterkilling occurs only occasionally. Often the dry soil prevents the wheat from coming up until spring. Soil drifting caused by high winds occurs in the Great Basin, especially on the lighter types of soil. Rust causes practically no loss to the wheat crop in the Great Basin area, but bunt (stinking smut) is a very destructive and widespread disease.

EXPERIMENTAL METHODS

The results reported here were obtained in field plats ranging from one-hundredth to one-tenth acre in area at the different stations or during different seasons. Nursery experiments were conducted in rows at most of the stations for the preliminary testing of new varieties and selections, but are not reported here. The experimental conditions, such as crop sequence, size of plat, width of alleys, and number of replications, vary somewhat at different stations. The results obtained at one station, therefore, are not necessarily comparable with those obtained at any other station. In many cases, however, they probably are directly comparable. The results from different varieties at the same station were nearly always obtained under similar conditions and may be compared directly. Any known exceptions to this fact are stated. In all cases the crops were grown with only the natural rainfall and under conditions approximating good farm practice for the district. Many of the experiments were conducted on summer-fallowed land. Summer fallowing is the common method of seed-bed preparation for winter wheat in the Great Basin and frequently is practiced in the Great Plains. At some stations during recent years two plats of each variety have been sown on fallow and two plats on corn ground or fall-plowed stubble.

NUMBER AND SIZE OF PLATS

Previous to 1912 nearly all varieties were grown in single plats, and check plats of a standard variety were sown at intervals of about every third or fifth plat. In this bulletin the yields from the single plats are not computed to the average of the checks, and the actual yields only are reported. Most of these tenth-acre plats were 2 by 8 rods in area. Since 1915 nearly all experiments have been replicated by sowing two to five plats of each variety. The number of replications may have varied from year to year and at different stations. The replicated plats were mostly the width of the grain drill and 8 rods in length, or about one-fortieth or one-fiftieth of an acre each in area. In the textual discussions of the yields of the varieties at each station, the number of plats sown to each variety is stated.

INTERPRETATION OF THE RESULTS

In the tables showing the results obtained at the different stations the actual acre yield of each variety is reported for each year in which it was grown. Where the plats were replicated the recorded yields are the averages for all plats of a variety. Probable errors of these averages, or means, of the results from replicated plats are not given. The yields were tabulated from the annual reports of the field-station men previously mentioned.

Because of the great variability of the yields of wheat from year to year the average yield of a variety for the entire period grown is the most important. The yield of each variety has been compared with the yield of Kharkof each year, and the average plus or minus difference is recorded. The probability of these differences recurring is expressed in odds obtained by the "Student" [2] method for determining the probable error of the mean, as follows:

$$\text{Mean} \div \text{Standard deviation} = Z$$

[2] Student, The probable error of a mean. Biometrica 6: 1–25. 1908

The odds are then computed from the probability tables for different values of Z and n (the number of samples). In determining the average difference of the mean the computation was carried to only one decimal place. For the value of Z the results were computed to three decimal places throughout this bulletin.[3]

A difference in yield between a given variety and the standard Kharkof, of +2 bushels per acre with odds of 10:1, for example, indicates that in these experiments the variety has an average acre yield 2 bushels higher than Kharkof and, based upon the results obtained, the odds are 10 to 1 that the variety is a higher yielder than Kharkof at that station.

Variations in the climatic conditions prevailing in both the Great Plains and Great Basin areas cause wide fluctuations in the yields of wheat from year to year at any station. These fluctuations often markedly affect the relative yields of two varieties from season to season and cause the odds or probabilities for the recurrence of the differences to be rather low.

The Kharkof variety is used as a standard for all comparisons discussed in this bulletin. Kharkof has been grown and is one of the leading varieties in nearly all of these experiments. It is listed under several C. I. numbers, including Nos. 1442, 1583, 2193, and 2208. All of the above lots were obtained from the same locality in the Kharkof Government of Russia but at different times. The lots of wheat appear to be identical except for C. I. No. 2193, which as now grown contains spikes having long beaks resembling Beloglina.

In the tables the yields and other data for Kharkof, C. I. No. 1442, are used as the standard. If this lot of Kharkof was not grown data are used from C. I. No. 1583. If neither was grown the data from C. I. Nos. 2193 or 2208, in the order named, were substituted.

VARIETAL EXPERIMENTS

The results of varietal experiments with winter wheat at 15 different experiment stations are presented here. At all of these stations the experiments have been conducted by the Office of Cereal Investigations either cooperatively with the State agricultural experiment station or some other agency or independently. The source of the data is stated in connection with each station.

While comparative yields have been the most important results obtained, other factors have been studied. Complete agronomic notes have been recorded on the varieties at most stations. Samples of most of the varieties also have been milled and the flour baked in the laboratory of the Milling Investigations Section, Grain Division, Bureau of Agricultural Economics of the United States Department of Agriculture. In addition to yield, therefore, data on the following important factors are summarized: Days from emergence to maturity, height of plant, percentage of stem-rust infection, test weight per bushel, percentage of winter survival, percentage of crude protein, yield of flour, and volume of loaf.

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[3] The writers desire to acknowledge the assistance of John R. Hooker in tabulating the yield data and in determining the odds by the "Student" method.

TABLE 3.—*Yields of 22 varieties and strains of winter wheat grown at the Amarillo Cereal Field Station, Amarillo, Tex., during the 14-year period from 1906 to 1919, inclusive, compared with those of Kharkof for comparable years*

[Data obtained in cooperation with the Amarillo Chamber of Commerce]

Class and variety	C. I. No.	Yield per acre (bushels)														Years compared	Average		Difference	Odds	Percentage of Kharkof
		1906	1907[1]	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919		Variety named	Kharkoi, same years			
Hard red winter:																					
Beloglina	1667	24.3	3.8	14.3	0	10.9	1.9	15.2	6.2	24.8	20.8	2.8	12.3	0	17.2	14	11.0	9.5	+1.5	31.4:1	115.8
Do	2239	20.1	3.6	9.1	0	8.6	2.2	13.5	5.3	23.7	.....	.....	.....	.....	.....	9	9.6	10.2	−.6	3.1:1	94.1
Crimean	1436	17.6	2.7	17.0	0	7.0	2.1	12.2	1.0	22.0	.....	.....	.....	.....	.....	9	9.1	10.2	−1.1	10.2:1	89.2
Do	1437	20.9	3.0	.....	0	10.4	2.0	13.3	10.0	25.3	20.2	4.3	12.4	0	19.6	13	10.9	9.1	+1.7	21.5:1	119.8
Kanred	5146	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13.7	0	20.0	3	11.2	8.0	+3.2	6.4:1	140.0
Kharkof	1442	.....	.....	.....	.....	.....	.....	11.8	2.8	25.5	.....	.....	.....	.....	.....	3	13.4	.....	.....	.....	.....
Do	2208	21.9	2.8	14.3	[2]2.8	8.4	1.6	13.8	3.2	22.3	13.0	4.3	11.2	0	12.8	3	13.1	13.4	−.3	1.3:1	97.8
Do	5293	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.5	13.1	0	16.9	4	8.9	7.1	+1.8	14.7:1	125.4
Theiss	1561	24.9	1.7	8.2	0	8.0	2.2	12.5	3.3	26.0	.....	.....	.....	.....	.....	9	9.6	10.2	−.6	2.9:1	94.1
Turkey	1558	25.8	3.3	23.2	0	10.2	1.6	16.0	6.5	26.8	19.2	5.0	12.3	0	18.0	14	12.0	9.5	+2.5	211.8:1	126.3
Do	2223	.....	2.9	23.1	0	10.9	1.9	13.5	8.9	26.3	19.8	4.7	13.5	0	17.2	13	11.0	8.6	+2.4	90.7:1	127.9
Do	2998	.....	.....	.....	.....	.....	.....	12.0	4.3	21.0	16.2	3.5	12.8	0	13.1	8	10.4	10.2	+.2	1.3:1	102.0
Pesterboden	1564	25.2	1.7	7.8	0	8.0	1.8	14.2	2.3	24.0	.....	.....	.....	.....	.....	9	9.4	10.2	−.8	3.7:1	92.2
Rieti	2942	.....	4.6	14.9	0	5.4	6.8	12.2	3.5	24.2	.....	.....	.....	.....	.....	8	9.0	8.8	+.2	.9:1	102.3
Weissenberg	1563	21.0	4.3	9.2	0	7.2	1.7	13.7	2.5	23.0	.....	.....	.....	.....	.....	9	9.2	10.2	−1.0	8.5:1	90.2
Soft red winter:																					
Diehl-Mediterranean	1395–2	18.5	1.4	25.8	0	10.4	.4	14.3	4.8	23.0	18.0	3.2	12.0	0	18.5	14	10.7	9.5	+1.2	5.9:1	112.6
Jejar	2092	.....	2.8	21.7	0	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	4	6.1	7.1	−1.0	1.6:1	85.9
Mammoth Red	2902	.....	2.9	21.0	7.6	7.0	3.3	14.8	4.2	25.2	.....	.....	.....	.....	.....	8	10.8	8.8	+2.0	24.8:1	122.7
Mediterranean	2900–1	.....	2.0	5.8	6.7	6.6	.....	.....	.....	.....	.....	.....	.....	.....	.....	4	5.3	7.1	−1.8	2.8:1	74.6
Do	2900–2	21.9	1.7	11.1	0	4.7	.....	.....	.....	.....	.....	.....	.....	.....	.....	5	7.9	10.0	-2.1	57.8:1	79.0
Do	2901	.....	2.9	14.7	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	5.9	6.6	−.7	2.9:1	89.4
Nebraska No. 28	5147	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11.3	0	21.7	3	11.0	8.0	+3.0	3.8:1	137.5

[1] Low yields partly due to damage by hail.

[2] Average of six plats.

ACRE YIELD

The yields from the principal winter-wheat varieties under experiment are shown for each station. Unimportant varieties that were grown for only one or two years in the early part of the experiments are not included in the station tables, and all varieties grown less than three years are omitted from the summary table on yields.

The annual and average yields obtained from winter-wheat varieties grown in plats at each of the 15 stations are shown in Tables 3 to 18. Where more than one plat was grown the number of plats of each variety is stated in the text. The difference between the average yield of each variety in the years grown and that of the Kharkof variety in the same years, together with the odds of the difference recurring in more extended experiments, is recorded. Finally, the yield of each variety in percentage of that of Kharkof is shown.

Great Plains Area

Yields were obtained from the hard red winter-wheat varieties at 10 experiment stations in the Great Plains area. The stations are arranged by States and in general from south to north. The winter conditions are too severe for winter wheat to be generally grown in the vicinity of the stations in North Dakota, South Dakota, and Wyoming, but in the sections where the other stations are located winter wheat is an important crop.

RESULTS AT AMARILLO, TEX.

The Amarillo Cereal Field Station was located in the center of the Texas Panhandle on a chocolate clay-loam soil at an altitude of 3,676 feet. The average annual precipitation for 28 years was 20.81 inches. The experiments were conducted by the Office of Cereal Investigations in cooperation with the Amarillo Chamber of Commerce. The yields of the winter-wheat varieties at Amarillo are shown in Table 3.

The varieties were grown in single plats from 1906 to 1915, in duplicate plats in 1916, and in triplicate plats from 1917 to 1919. All of the experiments were conducted on summer-fallowed land.

The crop of 1907 was heavily damaged by hail. Drought was largely responsible for the complete failure of the 1918 crop and for the very low yields in 1909, 1911, 1913, and 1916. The average yields of all varieties are very low. The 14-year average yield of the standard Kharkof was 9.5 bushels per acre. This variety was outyielded by several of the other hard red winter varieties. Turkey, C. I. No. 2223, produced an average yield of 2.4 bushels per acre more than Kharkof in 13 years. Kanred, in a 3-year period, of which one year was a failure, exceeded Kharkof by 3.2 bushels per acre, or 40 per cent. Nebraska No. 28, a soft red winter variety, showed the next highest comparative yield, but, like Kanred, was harvested in only two seasons. Two other soft red winter wheats, Mammoth Red and Diehl-Mediterranean produced slightly larger average yields than Kharkof.

RESULTS AT HAYS, KANS.

The Fort Hays Branch Experiment Station is located on a silty clay-loam soil at an altitude of 2,000 feet. During a 50-year period the average precipitation has been 22.96 inches. The experiments

have been conducted cooperatively by the Office of Cereal Investigations and the Kansas Agricultural Experiment Station. The yields are shown in Table 4.

The varieties were grown in single plats from 1912 to 1916. Since 1917, four systematically replicated plats of each variety were grown, unless noted, except in 1918, when five plats of each variety were used. Summer-fallowed land was used for the experiments from 1912 to 1918, but since 1919 two plats have been grown on cropped land and two on summer fallow.

Of the varieties grown during three or more years, Blackhull, Kanred, P–1066, and P–1068 have distinctly exceeded the standard Kharkof, C. I. No. 2193. A few other varieties have exceeded Kharkof by an average of less than 1 bushel per acre. Blackhull and Kanred show the highest comparative yields. During the 4-year period in which both have been grown Kanred has yielded 0.7 bushel more per acre than Blackhull.

RESULTS AT AKRON, COLO.

The Akron Field Station of the Office of Dry-Land Agriculture Investigations at Akron, Colo., lies at an altitude of 4,560 feet on a sandy loam soil. The average annual precipitation in the past 18 years has been 18.79 inches. Experiments with winter wheat have been conducted there since 1908 in cooperation with the Office of Dry-Land Agriculture Investigations. The yields are shown in Table 5.

The varieties were grown in single plats from 1908 to 1916, in duplicate plats in 1917, and in four systematically replicated plats in 1918 and from 1920 to 1922, inclusive. Summer-fallowed land was used for the varieties from 1908 to 1917, but since 1918 two plats have been grown on cornland and two on summer fallow.

All varieties were completely winterkilled in 1909. Experiments with winter wheat were not sown in the fall of 1918, so no yields were obtained in 1919 except from increase plats of Kanred and Kharkof. Kanred has produced the highest comparative yield during the period in which it has been grown. Other varieties or strains, grown during three or more years, which have outyielded the standard Kharkof, C. I. No. 1442, include Alberta Red, three lots of Crimean (C. I. Nos. 1436, 1437, and 1559), two other lots of Kharkof (C. I. Nos. 1583 and 4207), Malakof, Turkey (C. I. No. 1571), and Alton. Of these latter strains, however, only Kharkof, C. I. No. 1583, appears significantly better than the standard Kharkof.

RESULTS AT ARCHER, WYO.

The Cheyenne Field Station at Archer, Wyo., is located on a loam that is fairly sandy, containing some gravel. The altitude is almost exactly 6,000 feet. The normal rainfall is only 13.6 inches. The rainfall records are mostly from Fort D. A. Russell, near Cheyenne, 9 miles distant, where conditions probably are slightly more favorable than at Archer. The conditions of high altitude and northern latitude allow only a short growing season and this, combined with the low rainfall, makes crop growing somewhat difficult. The experiments were started in 1913 and were conducted by the Office of Cereal Investigations in cooperation with the Wyoming State Board of Farm Commissioners. In 1919 a change in the State law made the director of the Wyoming Agricultural Experiment Station the chairman of this board.

TABLE 4.—*Yields of 59 varieties and strains of winter wheat grown at the Fort Hays Branch Station, Hays, Kans., during the 10 years stated from 1912 to 1922, inclusive, compared with those of Kharkof for comparable years*

[Data obtained in cooperation with the Kansas Agricultural Experiment Station. Crop in 1915 destroyed by hail]

Class and variety	C. I. No.	Yield per acre (bushels)										Years compared	Average		Difference	Odds	Percentage of Kharkof
		1912	1913	1914	1916	1917	1918	1919	1920	1921	1922		Variety named	Kharkof, same years			
Hard red winter:																	
Altara	5797							5.2	28.9	23.5	13.1	4	17.7	19.1	−1.4	3.7:1	92.7
Alton	1438	8.8	[1]15.3	15.2	26.7	[2]16.7						4	16.5	22.5	−6.0	83.0:1	73.3
Beloglina (H–750)	1543			20.5	29.3	[2]10.9						2	24.9	28.0	−3.1	13.1:1	88.9
Blackhull	6251							9.5	33.1	33.0	14.5	4	22.5	19.1	+3.4	37.2:1	117.8
Crimean (P–761)	1435			21.3	31.9	18.9	10.3					4	20.6	22.0	−1.4	237.1:1	93.6
Do	1436	24.3	13.6	20.9	32.6	18.9	10.6	8.3	27.9	27.7	11.0	10	19.6	19.8	−.2	.8:1	99.0
Do	1437	22.5	5.6									2	14.0	17.0	−3.0	1.5:1	82.4
"Defiance"	6214							3.9	29.3	27.8	9.5	4	17.6	19.1	−1.5	4.1:1	92.1
Iowa No. 1946	6676									22.9	9.0	2	16.0	19.6	−3.6	9.4:1	81.6
Kanred	5146			25.6	36.4	20.9	10.8	12.6	34.9	29.1	16.0	8	23.3	20.5	+2.8	160.3:1	113.7
Karmont	6700									27.1	9.4	2	18.3	19.6	−1.3	5.3:1	93.4
Kharkof (6P2)	1442	16.2	23.2	23.0	34.4	20.2	13.7	6.8	26.0	28.0	12.3	10	20.4	19.8	+.6	3.4:1	103.0
Do	2193	16.8	17.2	22.9	33.1	20.7	11.1	9.0	28.0	27.7	11.5	10	19.8				
Kharkof (Hays No. 2)	6686				37.0	20.4	11.8	9.2	27.8	29.5	11.4	7	21.0	20.2	+.8	10.7:1	104.0
Kharkof (N–35)				22.5	34.0	20.8	10.7	9.0	22.3			6	19.9	20.8	−.9	4.0:1	95.7
Kharkof (N–63)						20.9	11.4					2	16.2	15.9	+.3	12.5:1	101.9
Kharkof (N–65)						15.5	11.6					2	13.6	15.9	−2.3	2.6:1	85.5
Kharkof (N–77)				25.3	34.7	20.3	11.1	6.8	25.9			6	20.7	20.8	−.1	.5:1	99.5
Kharkof (N–78)					31.7	19.8	11.3	10.0	27.6			5	20.1	20.4	−.3	2.8:1	98.5
Kharkof (N–322)						18.6	13.2	8.7				3	13.5	13.6	−.1	.5:1	99.3
Malakof	2908	16.4	18.4	22.7	30.9	18.7	13.8	6.6	27.3	25.8	11.4	10	19.2	19.8	−.6	6.2:1	97.0
Minturki	6155								22.7	21.2	7.1	3	17.0	22.4	−5.4	160.3:1	75.9
Montana No. 36	5549							9.8	21.9			2	15.9	18.5	−2.6	2.5:1	85.9
Nebraska No. 6	6249								26.4	28.1	13.2	3	22.6	22.4	+.2	1.3:1	100.9
Nebraska No. 60	6250								26.6	23.5	10.0	3	20.0	22.4	−2.4	15.6:1	89.3
Pesterboden	1564	17.3	18.6	21.1	31.2	19.6	10.7					6	19.8	20.3	−.5	5.4:1	97.5
P–1066	5879							10.8	29.8	29.9	10.6	4	20.3	19.1	+1.2	9.4:1	106.3
P–1068	5880							12.5	27.2	29.4	13.1	4	20.6	19.1	+1.5	9.6:1	107.9
Red Winter	6213								22.7	22.3		2	22.5	27.8	−5.4	237.1:1	80.6
Romanella (P–1036)				16.2	28.7							2	22.5	28.0	−5.5	14.5:1	80.4
Rumanian (No. 237)			12.7				13.8				12.8	3	13.1	13.3	−.2	.5:1	98.5
"Station Red"	6467									27.5	13.4	2	20.5	19.6	+.9	2.7:1	104.6
Tauranian (Ripka)	6202					20.4	12.3	9.8	27.2	25.3		5	19.0	19.3	−.3	2.0:1	98.4
Theiss	1561	17.5	14.0									2	15.8	17.0	−1.2	2.2:1	92.9

Turkey	1558								25.8	27.2	10.5	3	21.2	22.4	−1.2	13.2:1	94.0
Do	1571	19.8	18.4	21.2	33.9	19.2	10.1	8.2				7	18.7	18.7	0	1.0:1	100.6
Turkey (Improved)	5592			19.2	27.1	12.5		2.5	26.5	26.9	12.0	6	19.0	22.0	−3.0	38.2:1	86.4
Turkey (Kansas No. 1664)	6472								26.7	25.0	11.9	3	21.2	22.4	−1.2	5.4:1	94.6
Turkey (H–204) (Renners)			16.8	20.8	29.4	[2]10.6	11.9	7.1				5	17.2	18.6	−1.4	15.1:1	92.5
Turkey (Blender)						21.6	12.2	8.4				3	14.1	13.6	+.5	3.4:1	103.7
Turkey (Nygard)						[1]21.1	15.4	9.2	26.7			4	18.1	17.2	+.9	2.9:1	105.2
Turkey (Pioneer)	6613					[1]20.7	13.0	7.9	29.5	26.8	9.9	6	18.0	18.0	0	1.0:1	100.0
Turkey (Joy)							11.4	7.2				2	9.3	10.1	−.8	2.4:1	92.1
Turkey (No. 211)			22.6	22.6	31.9	17.6	10.0					5	20.9	21.0	−.1	.3:1	99.5
Turkey (H–3)			15.0	23.4	32.7	20.2	12.1	8.3				6	18.6	19.0	−.4	3.9:1	97.9
Turkey (N–1)						18.1	11.4	8.9				3	12.8	13.6	−.8	3.3:1	94.1
Turkey (N–12)						16.8	10.4					2	13.6	15.9	−2.3	4.2:1	85.5
Turkey (N–21)					33.3	16.8	10.9	9.3				4	17.6	18.5	−.9	5.6:1	95.1
Turkey (N–44)					35.2	20.4	12.1	8.9	27.2			5	20.8	20.4	+.4	3.1:1	102.0
Turkey (N–47)				[1]21.7	[1]31.1	17.8	11.6	8.2				5	18.1	19.3	−1.2	2.2:1	93.8
Turkey (N–50)						16.1	10.6					2	13.4	15.9	−2.5	3.7:1	84.3
Turkey (N–85)				21.0	31.8	17.2	10.1					4	20.0	21.9	−1.9	46.4:1	91.3
Turkey (N–321)						19.5	11.4	7.0				3	12.6	13.6	−1.0	6.2:1	92.6
Soft red winter:																	
Buffum No. 17	3330	5.0	1.0									2	3.0	17.0	−14.0	19.1:1	17.6
Fulcaster	6471									23.2	9.9	2	16.6	19.6	−3.0	6.2:1	84.7
Harvest Queen	6199								21.8	20.3	12.4	3	18.2	22.4	−4.2	7.1:1	81.3
Mediterranean	1395–2	18.0	8.3									2	13.2	17.0	−3.8	2.4:1	77.6
Minhardi	5149									19.6	5.3	2	12.5	19.6	−7.1	22.8:1	63.8
Nebraska No. 28	5147					11.3	6.7	8.9	24.1	21.1	16.5	6	14.8	18.0	−3.2	9.9:1	82.2

[1] Average of only two plats.

[2] Not comparable; smaller plats.

TABLE 5.—*Yields of 20 varieties and strains of winter wheat grown at the Akron Field Station, Akron, Colo., during the 15-year period from 1908 to 1922, inclusive, compared with those of Kharkof for comparable years*

[Data obtained in cooperation with the Office of Dry-Land Agriculture Investigations]

Class and variety	C. I. No.	Yield per acre (bushels)															Years compared	Average			Odds	Percentage of Kharkof
		1908	1909[1]	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919[2]	1920	1921	1922		Variety named	Kharkof, same years	Difference		
Hard red winter:																						
Alberta Red	2979	21.0	0						31.3	25.0	9.7	13.1					6	16.7	15.5	+ 1.2	4.1:1	107.7
Altara	5979													13.4	7.8		2	10.6	15.3	− 4.7	5.4:1	69.3
Alton	1438	15.6	0	38.5	15.8	38.3			22.8	21.0	6.6	14.3		14.4	15.4	11.3	12	17.8	17.6	+ .2	.7:1	101.1
Armavir	1355–2–2											18.0		17.2			2	17.6	14.2	+ 3.4	5.5:1	123.9
Beloglina	1543		0	23.6					18.4	21.3	9.0	12.2					6	14.1	16.7	− 2.6	10.6:1	84.4
Blackhull	6251													11.8	18.0	8.9	3	12.9	15.3	− 2.4	3.2:1	84.3
Crimean	1436	19.1	0	38.3	17.9	33.1	12.6	28.3	26.6	20.5	7.0	16.4		19.2	16.7	10.6	14	19.0	18.1	+ .9	3.2:1	105.0
Do	1437	14.6	0	34.8	13.3	32.5			26.6								6	20.3	20.1	+ .2	.8:1	101.0
Do	1559		0	36.9	11.5	32.7	17.0	39.6	29.0	21.7	7.1	15.6					10	21.1	18.7	+ 2.4	9.8:1	112.8
Kanred	5146										17.6	20.0	[3]21.3	30.1	14.3	14.5	5	19.3	14.3	+ 5.0	12.1:1	135.0
Karmont	6700														11.1	12.9	2	12.0	15.1	− 3.1	11.4:1	79.5
Kharkof	1442	20.6	0	27.9	10.0	34.3	16.1	26.6	27.5	19.2	12.9	12.8		15.6	15.0	15.2	14	18.1				
Do	1583	19.3	0	29.8	14.2	37.5	16.6	26.0	29.2	26.2	16.9	12.3	[3]17.6	16.1	13.0	14.2	14	19.4	18.1	+ 1.3	23.2:1	107.2
Do	4207				10.3	33.2	18.5	26.1	28.3	29.0	13.5	12.8		17.9	10.0	13.1	11	19.3	18.7	+ .6	2.7:1	103.2
Malakof	2908		0	26.7	17.3	35.4			30.5	18.3	9.0	12.2					8	18.7	18.1	+ .6	2.2:1	103.3
Minturki	6155													18.1	7.0	9.1	3	11.4	15.3	− 3.9	4.7:1	74.5
Montana No. 36	5549													18.7	10.0	14.6	3	14.4	15.3	− .9	1.6:1	94.1
Turkey	1571	19.8	0	29.5	11.7	43.1	[4]7.3	25.1	28.1	31.7	8.5	18.4		21.7	15.3	12.7	14	19.5	18.1	+ 1.4	4.5:1	107.7
Do	2998								23.3	30.8	6.1	10.3					4	17.6	18.1	− .5	.7:1	97.2
Soft red winter:																						
Buffum No. 17	3330					17.5	6.5	13.8							9.6	7.9	5	11.1	21.4	−10.3	293.1:1	51.9
Nebraska No. 28	5147										8.9	15.8		8.6			3	11.1	13.8	− 2.7	3.4:1	80.4

[1] All varieties winterkilled.
[2] Winter wheat not sown in plats, but Kanred and Kharkof grown in increase fields.
[3] Estimated yield, not included in average.
[4] Yield of a selection from Turkey 1571; original not grown.

The annual and average yields of the winter wheat varieties are given in Table 6. The varieties were grown in duplicate plats in 1913, single plats in 1914, and triplicate plats in 1915. Since 1917 four systematically replicated plats of each variety have been grown. Fallow land was used from 1913 to 1916, but since 1917 two plats have been seeded on cornland and two on fallow.

Yields of winter wheat were obtained during each of the years from 1913 to 1921, inclusive, except in 1916, when the crop was completely winterkilled. Six varieties produced higher average yields than the standard Kharkof, but none had significantly higher yields. Altara had the highest comparative yields but was grown in only two years. Kanred appears to be slightly superior to all other varieties.

TABLE 6.—*Yields of 20 varieties and strains of winter wheat grown at the Cheyenne Field Station, Archer, Wyo., during the 9-year period from 1913 to 1921, inclusive, compared with those of Kharkof in comparable years*

[Data obtained in cooperation with the Wyoming State Board of Farm Commissioners]

Class and variety	C. I. No.	Yield per acre (bushels)									Years compared	Average		Difference	Odds	Percentage of Kharkof
		1913	1914	1915	1916[1]	1917	1918	1919	1920	1921		Variety named	Kharkof, same years			
Hard red winter:																
Alberta Red	2979	----	7.7	37.8	0	16.0	30.6	5.4	17.2	24.2	8	17.4	16.9	+0.5	3.1:1	103.0
Altara	5797	----	----	----	----	----	----	----	17.6	22.3	2	20.0	18.5	+1.5	4.1:1	108.1
Alton	1438	9.3	7.8	37.6	0	19.0	33.7	5.7	14.2	21.4	9	16.5	16.1	+.4	3.9:1	102.5
Armavir	1355-2-2	----	4.0	32.6	0	13.7	28.7	6.8	17.6	22.1	8	15.7	16.9	−1.2	7.8:1	92.9
Beloglina	1543	----	5.0	36.8	0	15.4	30.0	5.0	11.3	19.8	8	15.4	16.9	−1.5	88.3:1	91.1
Blackhull	6251	----	----	----	----	----	----	----	9.0	25.4	2	17.2	18.5	−1.3	1.4:1	93.0
Crimean	1432	9.5	4.7	36.1	0	19.0	30.8	4.4	18.1	19.5	9	15.8	16.1	−.3	2.4:1	98.1
Do	1437	9.2	2.5	35.1	0	17.7	31.3	5.0	17.2	22.4	9	15.6	16.1	−.5	5.8:1	96.9
Do	1559	9.7	3.2	38.6	0	17.7	32.9	4.7	18.0	23.7	9	16.5	16.1	+.4	3.2:1	102.5
Kanred	5146	----	----	----	----	----	29.7	7.5	21.0	22.6	4	20.2	18.8	+1.4	3.4:1	107.4
Kharkof	1442	9.8	4.7	37.1	0	18.4	31.6	6.5	15.1	21.9	9	16.1	----	----	----	----
Do	1583	----	6.0	35.6	0	19.7	31.7	4.2	15.9	20.7	8	16.7	16.9	−.2	1.9:1	98.8
Malakof	2908	10.3	0	37.6	0	17.4	30.8	5.4	17.7	22.6	9	15.8	16.1	−.3	2.5:1	98.1
Minturki	6155	----	----	----	----	----	----	----	16.6	13.0	2	14.8	18.5	−3.7	2.3:1	80.0
Red Russian	1532	----	5.6	32.8	0	16.0	29.1	4.0	16.6	20.8	8	15.6	16.9	−1.3	18.0:1	92.3
Red Winter	6213	----	----	----	----	----	----	----	11.3	21.2	2	16.3	18.5	−2.2	4.3:1	88.1
Turkey	1571	10.0	7.9	32.0	0	20.2	28.4	6.3	12.0	21.2	9	15.3	16.1	−.8	4.2:1	95.0
Do	2998	----	13.7	32.5	0	19.7	29.6	5.4	18.6	19.7	8	17.4	16.9	+.5	1.6:1	103.0
Soft red winter:																
Buffum No. 17	3330	----	12.8	27.1	0	19.7	35.7	3.0	17.2	13.7	8	16.2	16.9	−.7	1.8:1	95.9
Diehl-Mediterranean	1395	----	4.5	38.0	0	16.4	33.4	6.0	----	----	6	16.4	16.4	0	1.0:1	100.0

[1] Winterkilled.

RESULTS AT SHERIDAN, WYO.

The Sheridan Field Station is located in northern Wyoming at an altitude of 3,800 feet on dark clay-loam soil. The average annual precipitation during 23 years was 14.72 inches. The cereal experiments were started in 1917 in cooperation with the Office of Dry-Land Agriculture Investigations. Since 1921 the experiments have been conducted by that office, which has furnished the data reported for 1922. The annual and average yields of the winter-wheat varieties are given in Table 7. The varieties have been grown on fallow land in three systematically replicated plats.

Seven varieties have been grown at Sheridan during the 6-year period from 1917 to 1922, inclusive. With the exception of Kanred all varieties were grown in each of the six years. The average yield of Kharkof is 26.7 bushels per acre, all other varieties yielding significantly less.

TABLE 7.—*Yields of seven varieties and strains of winter wheat grown at the Sheridan Field Station, Sheridan, Wyo., during the 6-year period from 1917 to 1922, inclusive, compared with those of Kharkof in comparable years*

[Data obtained in cooperation with the Office of Dry-Land Agriculture Investigations]

Class and variety	C. I. No.	Yield per acre (bushels)						Years compared	Average		Difference	Odds	Percentage of Kharkof
		1917	1918	1919	1920	1921	1922		Variety named	Kharkof, same years			
Hard red winter:													
Alton	1438	6.6	44.1	9.6	33.3	15.3	30.5	6	23.2	26.7	−3.5	24.6:1	86.9
Beloglina	1543	7.7	42.4	8.9	32.0	18.0	26.0	6	22.5	26.7	−4.2	160.3:1	84.3
Crimean	1559	8.0	44.5	13.9	36.3	21.9	27.8	6	25.4	26.7	−1.3	34.8:1	95.1
Kanred	5146	------	43.3	11.9	32.0	22.1	26.0	5	27.1	30.1	−3.0	30.1:1	90.0
Kharkof	1442	9.3	44.4	17.2	38.4	22.1	28.5	6	26.7	------	------	------	------
Turkey	1571	9.3	42.8	11.4	34.7	18.2	29.1	6	24.3	26.7	−2.4	29.7:1	91.0
Soft red winter:													
Buffum No. 17	3330	6.0	42.2	10.3	30.9	11.9	14.7	6	19.3	26.7	−7.4	221.2:1	72.3

RESULTS AT NEWELL, S. DAK.

The Belle Fourche Experiment Farm of the Office of Western Irrigation Agriculture Investigations is located at an altitude of 2,900 feet on the Belle Fourche Reclamation Project, near the town of Newell, 25 miles northeast of the Black Hills. The soil is a heavy clay or gumbo, classed as Pierre clay, with a shale subsoil. The average annual rainfall for 12 years has been 14.31 inches. Cereal experiments have been conducted since 1908 in cooperation with the Office of Western Irrigation Agriculture Investigations, and from 1912 to 1917 also under cooperative agreement with the South Dakota Agricultural Experiment Station. The experiments reported here were conducted wholly under dry-farming methods. The climate is not materially influenced by the proximity of the Black Hills, so that drought, hot winds, and severe winter temperature are important factors in limiting crop production. The more important yields are shown in Table 8.

The wheat was sown on summer-fallowed land each year. Single plats of all varieties were grown from 1908 to 1912. In 1913 and 1914 five plats of each variety were grown, but from 1915 to 1917, inclusive, only three systematically distributed plats were used.

Yields of winter varieties were obtained at Newell, S. Dak., in each year from 1908 to 1917, inclusive, except in 1911 and 1912, when the crops were destroyed by drought. The wheat sown in the fall of 1917 was completely winterkilled, and no yields were obtained.

All varieties produced lower average yields than Kharkof except Theiss, which equaled the yield of Kharkof. The varieties which were grown for 10 years show average yields practically identical with Kharkof. The relatively lower yield of Turkey, C. I. No. 3055, was due to the failure of the 1910 crop to emerge.

TABLE 8.—*Yields of 14 varieties and strains of hard red winter wheat grown at the Belle Fourche Experiment Farm, Newell, S. Dak., during the 10-year period from 1908 to 1917, inclusive, compared with those of Kharkof in comparable years*

[Data obtained in cooperation with the Office of Western Irrigation Agriculture Investigations and from 1912 to 1917 in cooperation with the South Dakota Agricultural Experiment Station]

Class and variety	C.I. No.	Yield per acre (bushels)										Years compared	Average		Difference	Odds	Percentage of Kharkof
		1908	1909	1910	1911	1912	1913	1914	1915	1916	1917		Variety named	Kharkof, same years			
Alberta Red	2979	----	----	16.7	0	0	35.0	----	64.2	11.6	----	6	21.3	23.2	−1.9	16.5:1	91.8
Alton	1438	----	----	----	----	----	----	----	53.7	11.1	6.5	3	23.8	27.6	−3.8	4.2:1	86.2
Beloglina	1667	----	----	19.2	0	0	37.2	29.9	63.8	11.7	10.3	8	21.5	21.6	−.1	.3:1	99.5
Do	2239	----	----	19.2	0	0	39.4	29.3	59.4	7.8	----	7	22.2	24.0	−1.8	12.2:1	92.5
Crimean	1435	18.7	31.5	19.7	----	----	----	----	----	----	----	3	23.3	29.5	−6.2	28.6:1	79.0
Do	1437	25.3	36.0	20.3	0	0	36.4	----	----	----	----	6	19.7	21.2	−1.5	20.6:1	92.9
Kharkof	1442	25.4	40.3	22.7	0	0	38.6	28.7	63.8	14.2	4.7	10	23.8	----	----	----	----
Do	1583	22.5	39.0	23.6	0	0	38.8	29.1	62.6	13.2	4.7	10	23.4	23.8	−.4	9.3:1	98.3
Do	4207	----	----	----	----	----	17.9	28.6	61.3	9.8	----	4	29.4	36.3	−6.9	7.4:1	81.0
Theiss	1561	----	----	19.4	0	0	36.8	31.6	66.3	12.3	6.4	8	21.6	21.6	0	1.0:1	100
Turkey	1558	24.1	41.0	17.8	0	0	38.1	----	65.0	10.3	5.1	9	22.4	23.3	−.9	7.3:1	96.1
Do	1571	25.5	39.0	20.3	0	0	38.7	29.6	65.0	12.3	6.0	10	23.6	23.8	−.2	2.1:1	99.2
Do	2943	----	----	15.0	0	0	39.3	----	60.1	9.1	----	6	20.6	23.2	−2.6	15.4:1	88.8
Do	3055	22.3	44.5	[1] 0	0	0	35.0	29.6	64.1	9.6	7.9	10	21.3	23.8	−2.5	5.0:1	89.5

[1] Did not emerge.

RESULTS AT HIGHMORE, S. DAK.

The Highmore substation of the South Dakota Agricultural Experiment Station is located near Highmore, S. Dak., on a glacial clay-loam soil at an altitude of 1,890 feet. The average annual rainfall has been 16.75 inches during 26 years. Cereal experiments were conducted by the South Dakota Agricultural Experiment Station in cooperation with the Office of Cereal Investigations from 1902 until 1919, when cooperation was discontinued. The testing of winter wheats was started in the fall of 1914, and the yields obtained are shown in Table 9.

TABLE 9.—*Yields of 11 varieties and strains of winter wheat grown at the Highmore substation, Highmore, S. Dak., during the 5-year period from 1915 to 1919, inclusive, compared with those of Kharkof in comparable years*

[Data obtained in cooperation with the South Dakota Agricultural Experiment Station]

Class and variety	C. I. No.	Yield per acre (bushels)					Years	Average		Difference	Odds	Percentage of Kharkof
		1915	1916	1917[1]	1918	1919		Variety named	Kharkof, same years			
Hard red winter:												
Kanred	5146	------	------	------	27.1	[2]27.8	2	27.5	20.9	+6.6	39.0:1	131.6
Kharkof	1442	5.5	39.2	0	20.0	21.7	5	17.3	----	----	----	----
Do	1583	11.0	45.8	0	20.0	21.7	5	19.7	17.3	+2.4	9.9:1	113.9
Do	4207	11.9	37.5	0	22.5	24.4	5	19.3	17.3	+2.0	8.1:1	111.6
Theiss	1561	9.1	30.0	0	23.3	23.1	5	17.1	17.3	−.2	.3:1	98.8
Turkey	1558	5.5	33.3	0	16.2	22.9	5	15.6	17.3	−1.7	6.2:1	90.2
Do	3055	7.3	32.5	0	24.0	21.0	5	17.0	17.3	−.3	.9:1	98.3
Do	3689	14.6	38.3	0	17.5	23.5	5	18.8	17.3	+1.5	3.0:1	108.7
Do	2943	4.6	30.8	0	14.1	21.9	5	14.3	17.3	−3.0	11.3:1	82.7
Soft red winter:												
Buffum No. 17	3330	11.0	13.3	0	27.5	6.7	5	11.7	17.3	−5.6	3.6:1	67.6
Nebraska No. 28	5147	------	------	------	13.3	19.5	2	16.4	20.9	−4.5	5.8:1	78.5

[1] Winterkilled.

[2] Average of two plats.

The experiments at Highmore were conducted in single plats; consequently the variations in yield are rather large. Kanred during two seasons produced significantly higher yields than Kharkof. Two other lots of Kharkof (C. I. Nos. 1583 and 4207) and Turkey (C. I. No. 3689) produced slightly higher yields than the standard Kharkof, C. I. No. 1442, during the 5-year period.

RESULTS AT DICKINSON, N. DAK.

The Dickinson substation of the North Dakota Agricultural Experiment Station is located on the border of the Heart River Valley, near Dickinson, N. Dak., on a soil varying from sandy loam to clay loam. The altitude is 2,453 feet, and the average annual precipitation has been 15.29 inches in a 31-year period. The varietal experiments conducted cooperatively by the North Dakota Agricultural Experiment Station and the Office of Cereal Investigations were started in 1907, but data from winter wheat in plats have been obtained only since 1913. The yields obtained are shown in Table 10.

The varieties were sown in standing corn each year except 1914, when they were sown on fallow. Single plats were grown from 1913 to 1918 and duplicate plats from 1919 to 1922. All varieties were winterkilled in 1918 and 1920, although the Beloglina variety, which also was sown in wheat stubble, in 1918 partly survived the winter and yielded 5.2 bushels per acre. Owing to heavy winterkilling and drought the yields at Dickinson have been low in most seasons. Two varieties, Kanred and Turkey (C. I. No. 3084), have slightly outyielded Kharkof, but not significantly.

TABLE 10.—*Yields from 10 varieties and strains of winter wheat grown at the Dickinson substation, Dickinson, N. Dak., during the 10-year period from 1913 to 1922, inclusive, compared with those of Kharkof in comparable years*

[Data obtained in cooperation with the North Dakota Agricultural Experiment Station]

Class and variety	C.I. No.	Yield per acre (bushels)										Years compared	Average		Difference	Odds	Percentage of Kharkof
		1913	1914	1915	1916	1917	1918	1919	1920	1921	1922		Variety named	Kharkof, same years			
Hard red winter:																	
Beloglina	1543	12.4	9.2	20.7	18.7	19.4	0	4.4	0	3.3	39.4	9	14.2	14.2	0	1.0:1	100
Kharkof	1583	10.0	11.0	30.3	[1]16.3	16.4	0	2.9	0	2.9	37.9	9	14.2				
Kanred	5146	----	----	----	----	[2]12.0	0	4.2	0	2.8	44.4	5	12.7	12.0	+.7	1.8:1	105.8
Karmont	6700	----	----	----	----	----	----	----	0	2.3	38.8	3	13.7	13.6	+.1	1.4:1	100.7
Minturki	6155	----	----	----	----	----	----	----	----	4.4	33.5	2	19.0	20.4	−1.4	1.9:1	93.1
Turkey	1571	16.6	6.3	17.5	22.8	11.8	0	2.9	.0	3.4	40.3	9	13.5	14.2	−.7	1.7:1	95.1
Turkey (N. Dak. No. 1997)	3084	18.3	9.6	28.4	[1]16.3	16.2	0	3.7	0	----	----	7	13.2	12.4	+.8	2.6:1	106.5
Soft red winter:																	
Buffum No. 17	3330	----	----	----	14.2	20.0	0	2.9	0	2.6	37.7	7	11.9	12.5	−.6	2.6:1	95.2
Minhardi	5149	----	----	----	----	----	----	----	0	2.2	39.0	3	13.7	13.6	+.1	1.3:1	100.7
Nebraska No. 28	5147	----	----	----	----	[2]12.4	0	.9	0	----	----	3	4.4	6.4	−2.0	7.9:1	68.8

[1] Average yield of two varieties threshed together by mistake.
[2] Sown September 6; others August 23.

RESULTS AT WILLISTON, N. DAK.

The Williston substation of the North Dakota Agricultural Experiment Station is located near Williston, N. Dak., on a fine sandy loam soil in the valley of the Missouri River at an altitude of 1,875 feet. The normal annual rainfall is 15.07 inches. The experiments at Williston have been conducted cooperatively by the North Dakota Agricultural Experiment Station and the Office of Cereal Investigations. They were started in 1908 and discontinued at the close of the 1918 crop season. The yields of winter-wheat varieties are shown in Table 11.

The varieties were sown in standing corn or on fallow. Only single plats were used except in 1915, when three plats of each variety were grown.

Eight varieties of winter wheat were included in the experiments at Williston during the 8-year period from 1909 to 1916, inclusive. Kharkof was not grown during the last three years, so the comparative yields are for only five years. All varieties were completely winterkilled in 1912. The average yield of Kharkof was 14.3 bushels per acre. During the same period Beloglina yielded an average of 2.5 bushels per acre more than Kharkof, owing to its greater hardiness. Other hard red winter varieties yielded nearly the same or considerably less than Kharkof. Buffum No. 17, a hardy soft red winter wheat, yielded more than twice as much as Kharkof in 1913 and was considerably more productive than Beloglina during the period from 1913 to 1916, inclusive.

TABLE 11.—*Yields of eight varieties and strains of winter wheat grown at the Williston substation, Williston, N. Dak., during the 8-year period from 1909 to 1916, inclusive, compared with those of Kharkof in comparable years*

[Data obtained in cooperation with the North Dakota Agricultural Experiment Station]

Class and variety	C.I. No.	Yield per acre (bushels)								Years compared	Average			Odds	Percentage of Kharkof
		1909	1910	1911	1912[1]	1913	1914	1915	1916		Variety named	Kharkof, same years	Difference		
Hard red winter:															
Beloglina	1543	40.0	9.9	26.5	0	7.8	10.0	12.8	34.2	5	16.8	14.3	+2.5	6.0:1	117.5
Kharkof	1583	29.9	7.3	24.9	0	6.8	----	----	----	5	6.8	----	----	----	----
Kharkof	1442	----	----	----	----	9.5	----	----	----	1	----	----	----	----	----
Turkey (Grafton)	3696	19.9	7.2	26.1	0	----	----	----	----	4	13.3	15.5	−2.2	3.3:1	85.8
Do	3084	26.6	7.3	28.7	0	13.1	15.8	6.1	----	5	15.1	14.3	+.8	2.5:1	105.6
Turkey (Eversole)	3011	21.6	9.1	24.9	0	8.4	----	----	----	5	12.8	14.3	−1.5	3.5:1	89.5
Turkey (Reliable)	3699	----	8.7	18.2	0	7.1	----	----	----	4	8.5	10.4	−1.9	4.5:1	81.7
Soft red winter:															
Buffum No. 17	3330	----	----	----	0	15.6	17.1	6.4	38.4	2	7.8	4.8	+3.0	3.0:1	162.5

[1] Entire crop winterkilled.

RESULTS AT MOCCASIN, MONT.

The Judith Basin substation of the Montana Agricultural Experiment Station is located at Moccasin, Mont., on a dark clay-loam soil with a gravelly subsoil. It is at an altitude of 4,228 feet, and the average annual precipitation in 25 years was 16.51 inches. Cereal experiments, cooperative between the Montana Agricultural Experiment Station and the Office of Cereal Investigations, have been conducted at Moccasin since 1909. The yields of winter-wheat varieties are shown in Table 12.

TABLE 12.—*Yields of 33 varieties and strains of winter wheat grown at the Judith Basin substation, Moccasin, Mont., during the 14-year period from 1909 to 1922, inclusive, compared with those of Kharkof in comparable years*

[Data obtained in cooperation with the Montana Agricultural Experiment Station. Results marked with a star (*) are yields of acre plats]

Class and variety	C. I. No.	Yield per acre (bushels)														Years compared	Average		Difference	Odds	Percentage of Kharkof
		1909	1910	1911	1912	1913	1914[1]	1915[1]	1916	1917	1918	1919	1920	1921	1922		Variety named	Kharkof, same years			
Hard red winter:																					
Alberta Red	2979	.....	37.0	38.5	16.0	*34.0	25.5	49.1	0	0	.....	.....	.....	.....	.....	8	25.0	26.8	− 1.8	9.5:1	93.3
Alton	1438	.....	23.6	33.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	28.3	44.8	−16.5	7.7:1	63.2
Armavir	1335	.....	36.3	30.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	33.2	44.8	−11.6	20.6:1	74.1
Bacska	1562	.....	28.0	26.7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	27.4	44.8	−17.4	66.6:1	61.2
Beloglina	1543	26.7	40.5	29.8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	32.3	36.7	− 4.4	2.9:1	88.0
Do	1544	25.0	32.7	34.8	8.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4	25.1	31.8	− 6.7	10.2:1	78.9
Blackhull	6251	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8.3	29.3	2	18.8	26.1	− 7.3	31.5:1	72.0
Crimean	1432	23.7	34.0	40.3	12.7	31.8	.....	.....	.....	.....	.....	.....	.....	.....	.....	5	28.5	32.1	− 3.6	8.0:1	88.8
Do	1433	15.3	32.4	34.0	9.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4	22.8	31.8	− 9.0	127.2:1	71.7
Do	1435	30.7	40.1	33.3	18.0	*28.0	23.8	49.5	0	0	.....	.....	.....	.....	.....	9	24.8	26.1	− 1.3	2.9:1	95.0
Do	1436	24.2	34.2	32.7	11.5	30.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	5	26.5	32.1	− 5.6	15.6:1	82.6
Do	1437	27.5	37.4	40.2	14.7	*35.3	22.7	51.0	0	0	.....	.....	.....	.....	.....	9	25.4	26.1	− .7	2.1:1	97.3
Do	1559	25.0	35.3	40.0	10.0	35.0	22.4	49.2	0	0	20.4	.....	.....	.....	.....	10	23.7	26.0	− 2.3	12.8:1	91.2
Kanred	5146	.....	.....	.....	.....	.....	.....	.....	.....	.....	22.5	5.3	20.0	14.9	35.4	5	19.6	21.0	− 1.4	30.3:1	93.3
Karmont	6700	.....	.....	.....	.....	.....	.....	.....	.....	.....	28.3	6.3	26.5	19.5	35.0	5	23.1	21.0	+ 2.1	23.0:1	110.0
Kharkof	1442	20.7	46.2	43.3	17.0	*33.1	25.5	49.0	0	0	.....	.....	.....	.....	.....	9	26.1	.....	.....	.....	.....
Do	1583	32.8	48.0	41.3	22.7	*31.1	24.5	49.4	0	0	25.4	5.3	21.9	16.3	35.9	9	27.8	26.1	+ 1.7	5.7:1	106.5
Do	2193	.....	40.8	38.2	18.3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	32.5	35.5	− 3.0	5.7:1	91.5
Minturki	6155	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	24.8	15.6	32.4	3	24.3	24.7	− .4	1.4:1	98.4
Montana No. 36	5549	.....	.....	.....	.....	.....	.....	.....	.....	.....	24.6	5.5	21.7	16.7	35.7	5	20.8	21.0	− .2	2.1:1	99.0
Red Russian	1532	18.3	29.4	33.7	14.0	29.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	5	24.9	32.1	− 7.2	33.8:1	77.6
Serbian	1728–4–1–10	.....	.....	.....	.....	.....	.....	.....	.....	.....	19.1	5.8	22.7	.....	.....	3	15.9	17.5	− 1.6	2.7:1	90.9
Torgova	1539	25.0	30.4	29.2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	28.2	36.7	− 8.5	5.3:1	76.8
Turkey	1558	21.7	43.7	43.7	22.7	*32.1	25.8	49.2	0	0	18.3	5.5	22.0	14.5	35.6	14	23.9	24.3	− .4	1.9:1	98.4
Do	1571	23.3	41.6	37.7	21.5	29.7	.....	.....	.....	.....	.....	.....	.....	.....	.....	5	30.8	32.1	− 1.3	2.6:1	96.0
Do	1756	.....	28.4	28.7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	28.6	44.8	−16.2	33.4:1	63.8
Do	2998	.....	23.6	30.7	13.6	35.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	4	25.9	34.9	− 9.0	9.2:1	74.2
Weissenberg	1563	24.7	35.3	33.7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	31.2	36.7	− 5.5	4.4:1	85.0
Soft red winter:																					
Buffum No. 17	3330	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.0	19.6	15.7	32.6	4	18.7	19.9	− 1.2	4.1:1	94.0
Currell	2906	.....	22.6	31.7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	27.2	44.8	−17.6	8.6:1	60.7
Girgeh	1580–6–1–10	.....	.....	.....	.....	.....	.....	.....	.....	.....	18.3	6.0	23.2	.....	.....	3	15.8	17.5	− 1.7	2.4:1	90.3
Minhardi	5149	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.0	19.4	15.2	33.4	4	18.8	19.9	− 1.1	4.7:1	94.5
Zimmerman	2907	.....	25.4	33.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	29.2	44.8	−15.6	8.7:1	65.2

The experiments have been grown on summer fallow. Single plats were grown from 1909 to 1916, inclusive, acre plats being used from 1913 to 1916. Since 1917 the varieties have been grown in five systematically distributed plats one-fiftieth acre in size.

During the 14-year period from 1909 to 1922, 33 varieties or strains of winter wheat were included in the experiments at Moccasin. Two strains of Kharkof have been used as the standard, C. I. No. 1442 from 1909 to 1917, inclusive, and C. I. No. 1583 from 1918 to 1922, inclusive, although the latter was grown during the entire period. It had succeeded the former during the first nine years by 1.7 bushels per acre. During the five years from 1918 to 1922, inclusive, Kharkof (C. I. No. 1583) was exceeded in yield only by the Karmont, which is a selection of it developed at the Moccasin station.

Great Basin Area

Varietal experiments with hard red winter wheat have been conducted at five cooperative field stations in the Great Basin area. At Moro, Oreg., and Nephi, Utah, conditions are rather favorable for the production of winter wheat, while on nonirrigated land at the other three stations yields are very poor, owing largely to low precipitation and to injury from pests. Summer frost injury frequently occurs at Burns, Oreg. All of the yields reported here were obtained on summer-fallowed land.

RESULTS AT NEPHI, UTAH

The Nephi substation is located in the Juab Valley in the eastern part of Juab County, Utah, near the summit of the Levan Ridge. This is a ridge of land a few miles in width extending transversely across the valley floor south of the town of Nephi. The soil is a sandy clay loam. The altitude at the town of Nephi is 5,580 feet. The exact altitude of the substation on the ridge, 6 miles distant, has not been determined but is thought to be nearly 6,000 feet. The average annual precipitation is 13.27 inches in a 22-year period. The experiments at Nephi were conducted cooperatively by the Utah Agricultural Experiment Station and the Office of Cereal Investigations. The yields of the winter-wheat varieties at Nephi are shown in Table 13.

The varieties were grown in single plats from 1908 to 1913, inclusive, in duplicate plats from 1914 to 1916, inclusive, and in three systematically distributed plats from 1917 to 1921. All plats were one-tenth acre in size unless otherwise stated.

Results of varietal experiments with hard red winter wheat were obtained at Nephi during 14 seasons. The 14-year average yield of Kharkof was 21.2 bushels per acre. Of the varieties grown three years or more, only four had higher comparative yields than Kharkof. Crimean, C. I. No. 1437, produced an average of 1.6 bushels per acre more than Kharkof in 14 years. Based upon the odds this difference is not significant. The three other varieties produced average acre yields of not more than half a bushel above the yield of Kharkof. The yields of most of the hard red winter varieties were not greatly different from that of Kharkof. In 2-year experiments Minturki and Blackhull show promise.

TABLE 13.—*Yields of 59 varieties and strains of winter wheat grown at the Nephi substation, Nephi, Utah, during the 14-year period from 1908 to 1921, inclusive, compared with those of Kharkof in comparable years*

[Data obtained in cooperation with the Utah Agricultural Experiment Station]

Class and variety	C. I. No.	Yield per acre (bushels)														Years compared	Average		Difference	Odds	Percentage of Kharkof
		1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921		Variety named	Kharkof, same years			
Hard red winter:																					
Alberta Red	2979	34.3	14.3	12.8	24.2	19.7	8.3	35.0	29.8	10.3	19.5	22.3	16.5	20.5	32.7	14	21.4	21.2	−0.2	1.5:1	100.9
Altara	5797													[1]23.2	31.2	2	27.2	25.9	+1.3	1.8:1	105.0
Alton	1438	27.7	15.7	12.2	29.5	22.1	11.7	34.2	29.7	9.9	20.1	9.9	16.7	21.3	33.4	14	21.0	21.2	−.2	.5:1	99.1
Armavir	1355	28.3	21.3	14.0	21.0	22.3	10.3	35.5	27.3	[2]13.0	19.1	18.6	15.3	17.4	30.7	14	21.0	21.2	−.2	.9:1	99.1
Bacska	1562	34.0	13.0	16.7	17.7	17.8	5.4	34.5	28.0							8	20.9	22.8	−1.9	5.2:1	91.7
Banat	1560	22.7	14.5	13.5	27.9	13.8	5.7	34.7	36.7							8	21.2	22.8	−1.6	4.4:1	93.0
Beloglina	1544	15.0	15.2	12.0	21.5					11.5	19.2	23.3	15.2	21.7	31.9	10	18.7	20.4	−1.7	7.2:1	91.7
Do	1543	10.2	12.2	8.8	24.9											4	14.0	22.4	−8.4	32.6:1	62.5
Do	1667	33.3	9.3	13.5	17.2											4	18.3	22.4	−4.1	4.2:1	81.7
Blackhull	6251													[1]25.0	34.6	2	29.8	25.9	+3.9	5.6:1	115.1
Bosnian	1691	19.2	9.0	8.3	20.8											4	14.3	22.4	−8.1	768.2:1	63.8
Budapest	1739	21.2	12.7	7.3	25.5					5.2						5	14.4	19.8	−5.4	122.5:1	72.7
Bulgarian	2048	32.5	13.0	7.8	31.2	22.8	12.2	36.0	27.5	[2]19.7	17.9	15.5	15.6	17.0	32.8	14	21.5	21.2	+.3	.6:1	101.4
Crimean	1432	30.7	11.2	14.5	22.0	16.0	5.7	34.8								7	19.3	22.0	−2.7	16.4:1	87.7
Do	1433	27.5	8.7	13.0	23.3											4	18.1	22.4	−4.3	10.5:1	80.8
Do	1435	25.8	20.3	15.3	25.2	19.1	11.7	31.7								7	21.3	22.0	−.7	2.4:1	96.8
Do	1436	30.2	14.7	15.5	22.2	19.3	9.2	39.2	27.1	7.3						9	20.5	21.3	−.8	3.7:1	96.2
Do	1437	30.3	18.7	20.3	26.7	19.5	10.5	40.3	29.4	[2]23.0	20.0	15.3	14.1	16.9	33.8	14	22.8	21.2	+1.6	9.4:1	107.5
Do	1559	29.2	14.0	15.2	29.7	19.9	11.9	37.9		9.7						8	20.9	20.4	+.5	2.0:1	102.5
Hungarian	2034	31.3	12.5	8.5	27.7	16.9	9.7	38.0	25.4							8	21.3	22.8	−1.5	4.6:1	93.4
Do	2042	32.7	8.8	8.8	24.7											4	18.8	22.4	−3.6	4.0:1	83.9
Kharkof	1442	26.2	19.2	17.0	27.2	19.8	7.0	37.7	27.9	[2]9.3	18.3	21.0	14.4	19.0	32.7	14	21.2				
Do	1583	31.0	10.7	21.2	20.5	21.4	8.3	37.4								7	21.5	22.0	−.5	1.5:1	97.7
Malakof	2908	31.5	11.3	11.7	23.3	15.3	7.0	37.0	37.8	7.3						9	20.2	21.3	−1.1	3.6:1	94.8
Minturki	6155													35.4	36.1	2	35.8	25.9	+9.9	4.4:1	138.2
Pesterboden	1564	30.0	11.7	18.0	19.0	18.3	12.0	36.7	35.0	8.8						9	21.2	21.3	−.2	.3:1	99.1
Red Russian	1532	21.8	14.7	14.8	22.7	14.7	1.5	26.8								7	16.7	22.0	−5.3	999.0:1	75.9
Red Winter	6213													[1]20.9	28.2	2	24.6	25.9	−1.3	1.7:1	95.0
Rumanian	1656	24.5	10.0	15.5	24.5	22.0	3.7	37.5								7	19.7	22.0	−2.3	13.8:1	89.5
Do	1658	23.3	11.2	13.8	23.3											4	17.9	22.4	−4.5	61.5:1	79.9
Do	1662	25.7	13.5	16.7	16.5				30.5	4.1						6	17.8	21.1	−3.3	11.9:1	84.4
Serbian	1676	22.7	15.7	10.5	27.4	18.8	4.0	32.9	30.4							8	20.3	22.8	−2.5	44.2:1	89.0

Theiss	1561	24.5	7.8	14.5	25.5												4	18.1	22.4	−4.3	10.9:1	80.8
Torgova	1539	11.0	16.5	14.2	23.5												4	16.3	22.4	−6.1	13.1:1	72.8
Turkey	1558	26.2	19.7	12.3	28.5												4	21.7	22.4	− .7	1.7:1	96.9
Do	1571	33.0	15.3	20.5	14.7	22.1	11.9	34.7		3.5							8	19.5	20.4	− .9	2.0:1	95.6
Do	1756	32.2	17.3	11.5	19.0	17.8	11.9	33.4	21.3	6.2							9	19.0	21.3	−2.3	9.3:1	89.2
Do	1783	29.8	11.5	9.0	25.0	17.5	4.0	36.5	35.8	6.0							9	19.5	21.3	−1.8	5.3:1	91.5
Do	1784	26.3	2.3	2.5													3	10.4	20.8	−10.4	9.6:1	50.0
Do	2998	35.0	16.2	15.8	21.5	22.1	11.3	43.0	28.1	10.4	19.7	5.4	11.7	19.8	33.6		14	21.0	21.2	− .2	.3:1	99.1
Do	3055	34.2	12.3	5.3	26.4	13.9	3.0	33.0	33.3								8	20.2	22.8	−2.6	5.7 1	88.6
Ulta	1439	28.3	18.0	17.5	24.7	5.8	5.5	33.7	36.7								8	21.3	22.8	−1.5	2.8:1	93.4
Weissenberg	1563	32.7	13.8	16.3	20.3	17.7	6.9	35.5	34.7	7.1							9	20.6	21.3	− .7	2.0:1	96.7
Soft red winter:																						
Currell	2906	19.7	21.8	10.7	20.7												4	18.2	22.4	−4.2	11.5:1	81.3
Diehl-Mediterranean	1395–2	27.2	10.7	8.7	25.4												4	18.0	22.4	−4.4	11.3:1	80.4
Dietz										7.7	19.3	17.8					3	14.9	16.2	−1.3	4.0:1	92.0
Fultz										6.1	18.0	19.3					3	14.5	16.2	−1.7	10.2:1	89.5
Japanese	1787	25.5	23.3	12.3	24.2	18.4	3.3	23.2									7	18.6	22.0	−3.4	11.1:1	84.5
Japanese Squarehead	1788–1	23.5	9.7	4.3	21.5												4	14.8	22.4	−7.6	53.3:1	66.1
Lofthouse	3275		3.3	11.5	27.3	6.0		25.2	24.3		16.7	10.2					8	15.6	23.5	−7.9	269.3:1	66.4
Minhardi	5149													25.1	36.5		2	30.8	25.9	+4.9	12.9:1	118.9
Nebraska No. 28	5147										24.2	[3]16.9	6.3				3	15.8	17.9	−2.1	2.0:1	88.3
Odessa	3274		11.2	10.0	24.2					2.6	18.9	10.2	16.8	17.6	28.1		9	15.5	19.8	−4.3	112.8:1	78.3
Penquite (Japanese Velvet Chaff)	1757	23.5	9.7	4.3	15.1												4	13.2	22.4	−9.2	72.0:1	58.9
Zimmerman	2907	24.8	10.3	11.3	24.3												4	17.7	22.4	−4.7	29.5:1	79.0
Common white:																						
Genesee										7.7	22.0	17.3					3	15.7	16.2	− .5	1.4:1	96.9
Goldcoin	2996	27.7	17.0	10.7	21.2	10.1					20.5	2.2	11.4	15.3	31.6		10	16.8	21.5	−4.7	51.1:1	78.1
Kofod	2997	24.3	2.5	.8	32.7	7.8	1.9	42.5	23.8	21.3	16.6	10 5	13.4	24.8	29.4		14	18.0	21.2	−3.2	9.7:1	84.9
Club:																						
Hybrid 128	4326											6.7	15.2	17.8	35.2		4	18.7	21.8	−3.1	3.2:1	85.8

[1] Grown separately with Turkey No. 2998 as a check.

[2] Single twentieth-acre plats.

[3] Two plats.

RESULTS AT ABERDEEN, IDAHO

The Aberdeen substation is located in the Snake River Plains of southern Idaho on a sandy clay-loam soil containing some volcanic-ash material. The altitude is 4,400 feet. The average annual precipitation in 11 years has been only 9.33 inches. The substation is maintained cooperatively by the Idaho Agricultural Experiment Station and the Office of Cereal Investigations. The results obtained at Aberdeen are presented in Table 14.

The varieties were grown in single plats in 1913 and 1914, in duplicate plats in 1915, and in triplicate plats from 1916 to 1918, inclusive.

Yields of winter-wheat varieties were obtained during six seasons. The crop was almost a failure in 1916, 1917, and 1918. Kharkof was not grown in 1917, but the 5-year average yield of this variety was 17 bushels per acre. Only one variety, Turkey (C. I. No. 1571), outyielded Kharkof by an average of more than 1 bushel per acre. The slightly higher yields of this as well as of a few other varieties are not significant.

TABLE 14.—*Yields of 27 varieties and strains of winter wheat grown at the Aberdeen substation, Aberdeen, Idaho, during the 6-year period from 1913 to 1918, inclusive, compared with those of Kharkof in comparable years*

[Data obtained in cooperation with the Idaho Agricultural Experiment Station]

Class and variety	C. I. No.	Yield per acre (bushels)									Difference	Odds	Percentage of Kharkof
		1913	1914	1915	1916	1917	1918	Years compared	Average: Variety named	Average: Kharkof, same years			
Hard red winter:													
Alberta Red	2979	19.2	36.2	20.7	-----	13.7	4.3	4	20.1	19.7	+0.4	1.3:1	102
Alton	1438	30.3	30.2	21.6	4.2	11.7	3.9	5	18.0	17.0	+1.0	2.5:1	105.9
Argentine	1569	-----	36.2	19.4	6.2	13.0	3.5	4	16.3	15.5	+.8	1.9:1	105.2
Bacska	1562	16.5	35.2	18.4	-----	-----	-----	3	23.4	24.6	−1.2	1.6:1	95.1
Beloglina	1543	19.2	30.2	20.3	4.6	-----	-----	4	18.6	20.0	−1.4	6.4:1	93.0
Do	1549	22.0	29.7	20.7	4.4	-----	-----	4	19.2	20.0	−.8	9.1:1	96.0
Do	1667	-----	34.8	16.7	6.0	-----	-----	3	19.2	18.9	+.3	.7:1	101.6
Do	2239	-----	29.7	16.7	4.6	6.8	4.2	4	13.8	15.5	−1.7	8.9:1	89.0
Crimean	1432	-----	22.9	19.4	3.5	-----	-----	3	15.3	18.9	−3.6	15.0:1	81.0
Do	1433	11.0	25.6	20.3	4.2	-----	-----	4	15.3	20.0	−4.7	10.9:1	76.5
Do	1435	19.2	33.4	19.8	6.0	-----	-----	4	19.6	20.0	−.4	1.4:1	98.0
Do	1437	30.8	24.2	21.2	5.7	9.5	5.2	5	17.4	17.0	+.4	1.3:1	102.4
Do	1559	-----	25.6	17.1	6.8	-----	-----	3	16.5	18.9	−2.4	6.9:1	87.3
Kharkof	1442	23.3	29.3	21.2	6.2	-----	5.1	5	17.0	-----	-----	-----	-----
Do	1583	29.3	24.7	19.4	6.0	-----	-----	4	19.9	20.0	−.1	.4:1	99.5
Malakof	2908	29.3	25.6	20.7	5.3	-----	-----	4	20.2	20.0	+.2	.5:1	101
Pesterboden	1564	20.1	33.0	17.6	-----	-----	-----	3	23.6	24.6	−1.0	1.8:1	95.9
Theiss	1561	22.0	30.7	19.8	-----	13.7	4.6	4	19.3	19.7	−.4	3.0:1	98.0
Torgova	1539	18.3	29.3	22.1	3.7	-----	-----	4	18.4	20.0	−1.6	5.9:1	92.0
Turkey	1558	22.0	35.2	20.7	6.2	9.7	5.5	5	17.9	17.0	+.9	2.8:1	105.3
Do	1571	-----	38.5	20.3	5.5	7.3	4.5	4	17.2	15.5	+1.7	2.8:1	111.0
Do	2998	27.3	25.6	22.5	4.9	-----	-----	4	20.1	20.0	+.1	.2:1	100.5
Do	4061	17.4	32.1	16.7	6.0	-----	-----	4	18.1	20.0	−1.9	4.1:1	90.5
Soft red winter:													
Currell	2906	7.3	31.6	16.7	-----	-----	-----	3	18.5	24.6	−6.1	4.4:1	75.2
Jejar	2092	7.3	24.2	20.3	-----	-----	-----	3	17.3	24.6	−7.3	7.1:1	70.3
White:													
Goldcoin (Forty-fold)	2996	17.4	33.9	19.8	3.8	0	1.9	5	15.4	17.0	−1.6	4.2:1	90.6
Kofod	2997	1.8	23.3	12.6	-----	-----	-----	3	12.6	24.6	−12.0	14.5:1	51.2

RESULTS AT BURNS, OREG.

The Harney Branch Experiment Station is located near the town of Burns in an ancient lake bed now known as the Harney Valley. The soil varies from a silt loam to a very fine sandy loam. The altitude of the station is 4,100 feet, which is about that of the valley floor and lower than that of the plateau of south-central Oregon. The average annual precipitation during six years has been 7.49 inches. During the period of these experiments the station was conducted cooperatively by the Oregon Agricultural Experiment Station and the Office of Cereal Investigations. The varieties were grown in single plats on fallow. The yields are shown in Table 15.

Yields of hard red winter varieties were obtained at Burns during only four seasons. Winter wheats sown during the three seasons following 1916 were practically complete failures. The 4-year average yield of Kharkof was 16.2 bushels per acre. All of the hard red winter varieties grown during three or four seasons except Alton, Pesterboden, and Weissenberg have higher comparative yields than Kharkof. Four strains of Turkey, C. I. Nos. 1558, 2223, and 2998, and a local strain designated as I. S. G. appear to be significantly better than Kharkof during the limited period of the experiments. Owing to the nonuniform soil at Burns these yield differences probably are not very reliable.

TABLE 15.—*Yields of 17 varieties and strains of winter wheat grown at the Harney County Branch Station, Burns, Oreg., during the 4-year period from 1913 to 1916, inclusive, compared with those of Kharkof in comparable years*

[Data obtained in cooperation with the Oregon Agricultural Experiment Station]

Class and variety	C. I. No.	Yield per acre (bushels)				Years compared	Average		Difference	Odds	Percentage of Kharkof
		1913	1914	1915	1916		Variety named	Kharkof, same years			
Hard red winter:											
Alberta Red	2979	22.5	14.7	26.3	------	3	21.2	20.6	+ 0.6	2.1:1	102.9
Alton	1438	18.9	16.7	25.0	------	3	20.2	20.6	— .4	1.2:1	98.1
Argentine	1569	26.0	9.3	28.9	4.4	4	17.2	16.2	+ 1.0	3.0:1	106.2
Beloglina	1543	24.0	12.3	27.0	1.5	4	16.2	16.2	0	1.0:1	100
Bulgarian	2048	------	------	35.0	1.1	2	18.1	15.0	+ 3.1	2.1:1	120.7
Kharkof	1442	22.7	12.0	27.1	2.9	4	16.2	------	------	------	------
Pesterboden	1564	15.2	13.7	27.0	------	3	18.6	20.6	— 2.0	2.6:1	90.3
Serbian	1676	------	------	30.3	.5	2	15.4	15.0	+ .4	1.2:1	102.7
Turkey	1558	26.0	19.3	30.7	4.0	4	20.0	16.2	+ 3.8	32.4:1	123.5
Do	2223	26.2	17.0	27.3	5.0	4	18.9	16.2	+ 2.7	24.6:1	116.7
Do	2998	24.2	14.0	28.1	4.2	4	17.6	16.2	+ 1.4	321.6:1	108.6
Turkey (I. S. G. local)	------	------	------	15.3	29.4	4.0	3	16.2	14.0	+ 2.2	25.8:1	115.7
Turkey (F. D. local)	------	33.5	9.0	27.2	------	3	23.2	20.6	+ 2.6	2.2:1	112.6
Weissenberg	1563	19.5	16.0	20.0	------	3	18.5	20.6	— 2.1	2.4:1	89.8
Soft red winter:											
Diehl-Mediterranean	1395	21.0	10.0	31.3	------	3	20.8	20.6	+ .2	.6:1	101
White:											
Kofod	2997	11.2	5.7	5.8	------	3	7.6	20.6	—13.0	19.4:1	36.9
Prohibition	4068	12.5	4.7	7.0	------	3	8.1	20.6	—12.5	22.8:1	39.3

TABLE 16.—*Yields of 37 varieties and strains of winter wheat grown at the Sherman County Branch Station, Moro, Oreg., during the 11-year period from 1912 to 1922, inclusive, compared with those of Kharkof in comparable years*

[Data obtained in cooperation with the Oregon Agricultural Experiment Station]

Class and variety	C. I. No.	Yield per acre (bushels)											Years compared	Average		Difference	Odds	Percentage of Kharkof
		1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922		Variety named	Kharkof, same years			
Hard red winter:																		
Alberta Red	2979	19.8	24.5	24.2	25.5	54.6	23.9	25.6	39.0	32.2	39.6	17.8	10	30.2	30.3	−0.1	0.3:1	99.7
Altara	5797										35.3	16.0	2	25.7	28.6	−2.9	4.7:1	89.9
Alton	1438	10.6		20.8	17.1	49.8	22.5	22.2					6	23.8	28.7	−4.9	18.2:1	82.9
Argentine	1569	23.1		26.1	25.0	53.6	25.3	25.1	37.5	32.2	40.6	16.8	10	30.5	30.3	+.2	1.8:1	100.7
Armavir	1355	30.5	18.4	19.5	21.0	53.0	24.3	22.3					6	28.4	28.7	−.3	1.6:1	99.0
Baeska	1562	20.2		25.9									2	23.0	25.8	−2.8	2.1:1	89.1
Beloglina	1544	12.3		17.0									2	14.7	25.8	−11.1	7.8:1	57.0
Do	2239	12.9		26.0	23.4	52.3	23.0	22.4	37.8				7	28.3	30.3	−2.0	4.3:1	93.4
Blackhull	6251									35.3	40.1	18.4	3	31.3	30.1	+1.2	8.2:1	104.0
Crimean	1432	14.5		21.0									2	17.8	25.8	−8.0	4.6:1	69.0
Do	1437	20.2		26.7	19.9	50.7	25.5	25.5	36.3				7	29.3	30.3	−1.0	3.3:1	96.7
Hussar	6553										33.0	17.4	2	25.2	28.6	−3.4	2.8:1	88.1
Kanred	5146						20.8	24.1	38.5	32.7	40.0	16.9	6	28.8	29.6	−.8	6.2:1	97.3
Kharkof	1442	27.6		24.0	21.3	52.3	24.3	22.9					6	28.7				
Do	1442-12						19.0	26.2	40.0	33.2	40.1	17.1	2	22.6	23.6	−1.0	1.3:1	95.8
Montana No. 36	5549								38.2	31.8			2	35.0	36.6	−1.6	24.3:1	95.6
Nebraska No. 60	6250									33.0	41.9	16.6	3	30.5	30.1	+.4	2.1:1	101.3
Rieti	2942	22.6		22.9									2	22.8	25.8	−3.0	4.6:1	88.4
Theiss	1561	13.6		27.5	24.7	54.0	22.2	22.6	38.2				7	29.0	30.3	−1.3	2.5:1	95.7
Torgova	1539	10.6		26.3	19.2								3	18.7	24.3	−5.6	3.6:1	77.0
Turkey	1558	17.6	24.0	22.4	20.6	55.0	26.0	23.6	38.1	33.0	38.4	17.3	10	29.2	30.3	−1.1	4.7:1	96.4
Do	1571	14.4		29.0	26.5	53.4	23.6	25.4	41.5	32.5	40.3	17.8	10	30.4	30.3	+.1	.3:1	100.3
Do	1756	22.0		17.3	21.7	55.0	24.6	25.1	38.4				7	29.2	30.3	−1.1	3.7:1	96.4
Do	2998	12.9		17.2	26.5	49.5	25.3	26.8	42.0	33.0			8	29.2	30.7	−1.5	2.9:1	95.1
Turkey (local)	4429	13.3		22.5	21.3	50.8	22.3	27.3	36.6	33.5	39.9	18.4	10	28.6	30.3	−1.7	5.5:1	94.4
Weissenberg	1563	15.0		26.0	20.9								3	20.6	24.3	−3.7	3.0:1	84.8
Soft red winter:																		
Diehl-Mediterranean	1395-2	23.1		19.0									2	21.1	25.8	−4.7	57.5:1	81.8
Jones Fife	4468								22.2	31.7	28.4		3	27.4	37.8	−10.4	11.3:1	72.5
Jones Fife (Super)	5544								25.7	32.7	30.3		3	29.6	37.8	−8.2	10.0:1	78.3
Purplestraw	1915		20.0	24.5	18.6								3	21.6	22.7	−1.1	2.2:1	95.2
Triplet	5408						28.8	26.7	37.1	35.7	38.7	20.8	6	31.3	29.6	+1.7	7.5:1	105.7
Zimmerman	2907	23.5		21.7									2	22.6	25.8	−3.2	10.4:1	87.6
White:																		
Goldcoin (Fortyfold)	4156	17.5	21.6	19.7	26.5				26.2	25.9	28.1	18.1	7	23.1	29.0	−5.9	28.8:1	79.7
Do	5290					38.0	21.8	25.9					3	28.6	33.2	−4.6	3.3:1	86.1
Kofod	2997	16.0		15.4									2	15.7	25.8	−10.1	20.3:1	60.9
Prohibition	4068	27.8		20.5	24.6	42.8	21.1						5	27.4	29.9	−2.5	5.5:1	91.6
Club:																		
Hybrid 128	4512							26.5	40.6	36.8	43.0	21.2	5	33.6	30.7	+2.9	237.1:1	109.4

RESULTS AT MORO, OREG.

The Sherman County Branch Station is located at Moro, Oreg., on silt-loam soil at an altitude of about 1,800 feet in the western part of the Columbia Basin of Oregon. The average precipitation in 18 years was 11.46 inches. The station is operated cooperatively by the Oregon Agricultural Experiment Station and the Office of Cereal Investigations. The yields of winter wheat obtained at Moro are shown in Table 16. The varieties have been grown on fallow and in tenth-acre or twentieth-acre plats. Single plats were grown from 1912 to 1915, duplicate plats in 1916, and triplicate plats from 1917 to 1922, inclusive.

The average yield of the standard Kharkof was 30.3 bushels per acre. From 1919 to 1922, inclusive, the standard yields used were those of the Kharkof selection (C. I. No. 1442–12). Of the hard red winter varieties only Blackhull has outyielded Kharkof by an average of more than 1 bushel per acre; Turkey (C. I. No. 1571), Argentine, and Nebraska No. 60 are the only other hard wheats that have exceeded Kharkof. None of the yields is significantly higher. Triplet, a soft red winter wheat, and Hybrid 128, a white club wheat, have noticeably outyielded Kharkof and the latter by a significant quantity.

RESULTS AT LIND, WASH.

The Adams Branch Experiment Station at Lind, Wash., is located on light soil basaltic in origin which has been more or less modified by wind. The altitude is 1,630 feet, and the average annual precipitation has been only 7.56 inches during the 4-year period from 1918 to 1921. During these years the station was operated cooperatively by the Washington Agricultural Experiment Station and the Office of Cereal Investigations. The yields obtained at Lind are shown in Table 17.

TABLE 17.—*Yields of 18 varieties and strains of winter wheat grown at the Adams Branch Experiment Station, Lind, Wash., during the 4-year period from 1918 to 1921, inclusive, compared with those of Kharkof in comparable years*

[Data obtained in cooperation with the Washington Agricultural Experiment Station]

Class and variety	C. I. No.	Yield per acre (bushels)				Years compared	Average		Difference	Odds	Percentage of Kharkof
		1918	1919	1920	1921		Variety named	Kharkof, same years			
Hard red winter:											
Alton	1438	6.0	11.2	7.4	6.8	4	7.9	9.5	−1.6	51.1:1	83.2
Beloglina	2239	6.1	13.2	8.8	8.4	4	9.1	9.5	−.4	3.5:1	95.8
Kanred	5146	6.5	15.5	9.6	9.4	4	10.3	9.5	+.8	6.6:1	108.4
Kharkof	1442	7.3	13.9	7.9	8.9	4	9.5				
Montana No. 36	5549			9.8	10.2	2	10.0	8.4	+1.6	15.4:1	119.0
"Station Red"	6467			10.6	8.9	2	9.8	8.4	+1.4	3.0:1	116.7
Turkey (Washington No. 326)	6175	7.6	14.7	7.1	11.8	4	10.3	9.5	+.8	4.3:1	108.4
Soft red winter:											
Jones Fife	6177	7.0	15.6	4.7	7.9	4	8.8	9.5	−.7	2.7:1	92.6
Jones Fife (Super)	5544		14.3	5.7	6.5	3	8.8	10.2	−1.4	6.6:1	86.3
Jones Fife (Crail Fife)	6182		16.8	4.2		2	10.5	10.9	−.4	1.2:1	96.3
Nebraska No. 28	5147		7.4	3.3		2	5.4	10.9	−5.5	17.6:1	49.5
Ruddy	6465		13.0	5.3		2	9.2	10.9	−1.7	6.1:1	84.4
"Station Fife"	6468			7.4	5.6	2	6.5	8.4	−1.9	4.0:1	77.4
Triplet	5408	5.8	14.5	5.4	6.9	4	8.2	9.5	−1.3	14.1:1	86.3
White:											
Goldcoin (Fortyfold)	6176	5.2	13.4	3.9	4.7	4	6.8	9.5	−2.7	36.3:1	71.6
Hybrid 128	4512	6.8	13.5	6.5	8.7	4	8.9	9.5	−.6	17.5:1	93.7
Hybrid 143	4513	6.5	12.1	3.9	9.1	4	7.9	9.5	−1.6	10.5:1	83.2
Winter Bluestem	5409	6.1	12.3	3.8		3	7.4	9.7	−2.3	14.8:1	76.3

TABLE 18.—*Average yields of 114 varieties and strains of winter wheat grown at 15 experiment stations in the Great Plains and Great Basin areas during three or more station years in the 17-year period from 1906 to 1922, inclusive*

[Yield per acre (percentage of Kharkof) compared with that of Kharkof at the same stations in the same years]

Class and variety	C. I. No.	Amarillo, Tex.	Hays, Kans.	Akron, Colo.	Wyoming		South Dakota		North Dakota		Moccasin, Mont.	Nephi, Utah	Aberdeen, Idaho	Oregon		Lind, Wash.
					Archer	Sheridan	Newell	Highmore	Dickinson	Williston				Burns	Moro	
Hard red winter:																
Kharkof (check)		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Alberta Red	2979			107.1	103		91.8				93.3	100.9	102	102.9	107.9	
Altara	5797		92.7													
Alton	1438		73.3	101.1	102.5	86.9	86.3				63.2	99.1	105.9	98.1	82.9	83.2
Argentine	1569												105.2	106.2	100.7	
Armavir	1355										74.1	99.1			99	
Armavir (selection)	1355-2-2				92.9											
Bacska	1562										61.2	91.7	95.1			
Banat	1560											93				
Beloglina	1543			84.4	91.1	84.3			100	117.5	88	62.5	93	100		
Do	1544										78.9	91.7				
Do	1549												96			
Do	1667	115.8					99.5					81.7	101.6			
Do	2239	94.1					92.5						89		100	95.8
Blackhull	6251		117.8	84.3							72				104	93.3
Bosnian	1691											63.8				
Budapest	1739											72.7				
Bulgarian	2048											101.4				
Crimean	1432				98.1						88.8	87.7	81			
Do	1433										71.7	79.9	76.5			
Do	1435		93.6				79				95	96.8	98			
Do	1436	89.2	99	105							82.6	96.2				
Do	1437	119.8		101	96.9		92.9				97.3	107.5	102.4		96.7	
Do	1559			112.8	102.5	95.1					91.2	102.5	87.3			
Defiance	6214		92.1													
Eversole	3011									89.5						
Hungarian	2034											93.4				
Do	2042											83.9				
Kanred	5146	140	113.7	135	107.4	90			105.8		93.3				97.3	108.4
Karmont	6700								100.7		110					
Kharkof (Selection No. 6P2)	1442		103													
Do	1583			107.2	98.8		98.3	113.9			106.5	97.7	99.5			
Do	2193										91.5					
Do	2208	97.8														
Do	4207			103.2			81	111.6								
Do	5293	125.4														
Kharkof (Montana No. 36)	5549			94.1							99					119

Kharkof (Hays No. 2)	6686		104													
Malakof	2208		97	103.3	98.1							94.8	101			
Minturki	6155		75.9	74.5							98.4					
P–1066	5879		106.3													
P–1068	5880		107.9													
Pesterboden	1564	92.2	97.5									99.1	95.9	90.3		
Red Russian	1532				92.3						77.6	75.9				
Reliable	3699									81.7						
Rieti	2942	102.3														
Rumanian (No. 237)			98.5													
Do	1656											89.5				
Do	1658											79.9				
Do	1662											84.4				
Serbian	1676											89				
Serbian (Selection No. 4–1–10)	1728										90.9					
"Station Red"	6467															116.7
Tauranian	6202		98.4												95.7	
Theiss	1561	94.1					101.4	98.8				80.8	98		77	
Torgova	1539										76.8	72.8	92		96.4	
Turkey	1558	126.3	94.6				96.1	90.2			98.4	96.9	105.3		100.3	
Do	1571		100	107.7	95	91	99.2		95.1		96	95.6	111		96.4	
Do	1756										63.8	89.2				
Do	1783											91.5				
Do	1784											50				
Do	2223	127.9												116.7		
Do	2943						88.8	82.7								
Do	2998	102		97.2	103						74.2	99.1	100.5	108.6	95.1	
Do	3055						89.5	98.3				88.6				
Do	3084								106.5	105.6						
Do	3689							108.7								
Do	4061												90.5			
Do	4429														94.4	
Turkey (Improved)	5592		86.4													
Turkey (Washington No. 326)	6175															108.4
Turkey (Kansas No. 1664)	6472		94.6													
Turkey (Blender)			103.7													
Turkey (Grafton)	3696									85.8						
Turkey (Nygard)			105.2													
Turkey (Pioneer)			100													
Turkey (Renner)			92.5													
Turkey (Nebraska No. 6)	6249		100.9													
Turkey (Nebraska No. 60)	6250		89.3												101.3	
Ulta	1439											93.4				
Weissenberg	1563	90.2									85	96.7	90.7	89.8	84.8	
Soft red winter:																
Buffum No. 17	3330			51.9	95.9	72.3		67.6	95.2		94					
Currell	2906										60.7	81.3	75.2			
Diehl-Mediterranean	1395				100									101		
Do	1395–2	112.6		97.5								80.4				
Dietz												92				
Fultz	6215											89.5				
Harvest Queen	6199		81.3													
Japanese	1787											84.5				

TABLE 18.—*Average yields of 114 varieties and strains of winter wheat grown at 15 experiment stations in the Great Plains and Great Basin areas during three or more station years in the 17-year period from 1906 to 1922, inclusive*—Continued

Class and variety	C. I. No.	Amarillo, Tex.	Hays, Kans.	Akron, Colo.	Wyoming		South Dakota		North Dakota		Moccasin, Mont.	Nephi, Utah	Aberdeen, Idaho	Oregon		Lind, Wash.
					Archer	Sheridan	Newell	Highmore	Dickinson	Williston				Burns	Moro	
Soft red winter—Continued.																
Japanese Squarehead	1788–1											66.1	70.3			
Jejar	2092	85.9													72.5	
Jones Fife	4468														78.3	
Jones Fife (Super)	5544															86.3
Jones Fife	6177															92.6
Lofthouse	3275											66.4				
Mammoth Red	2902	123.9														
Mediterranean	2901	89.4														
Minhardi	5149								100.7		94.5					
Nebraska No. 28	5147	137.5	82.2	80.4					68.8			88.3				49.5
Odessa	3274											78.3				
Penquite (Japanese Velvet Chaff)	1757											58.9				
Triplet	5408														105.7	86.3
Zimmerman	2907										65.2	79				
White:																
Genesee Giant												96.9				
Goldcoin (Fortyfold)	2996											78.1	90.6			
Do	4156														79.7	54.8
Do	5290														86.1	
Do	6176															71.6
Kofod	2997										60.3	84.9	51.2	36.9		
Prohibition	4068													39.3	91.6	
Winter Bluestem	5409															76.3
Club:																
Hybrid 128	4326											85.8				
Do	4512														109.4	93.7

The varieties were grown on fallow and in three systematically distributed plats. The average yield for the standard Kharkof was 9.5 bushels per acre. During the same 4-year period Kanred and Turkey (C. I. No. 6175) exceeded it by 0.8 bushel per acre, a difference which is not significant. During the 2-year period, 1920 and 1921, Montana No. 36, a selection of Kharkof, proved the most promising of any of the varieties tested.

SUMMARY OF YIELDS

In order to compare the yields of varieties at all of the 15 stations, the average yields of each variety, as expressed in percentages of the yield of the Kharkof variety during the same years at each station, are given in Table 18. A diagram showing the location of the 15 field stations is shown in Figure 1. The Kharkof variety has been included in all of the experiments. Other varieties have been grown during only a part of these years.

Table 18 shows that Alberta Red, C. I. No. 2979, slightly outyielded Kharkof at 6 of the 8 stations where it has been tested. Argentine, C. I. 1569, slightly exceeded Kharkof at all three stations where compared. Beloglina, C. I. No. 1543, equaled or exceeded Kharkof at 3 out of 9 stations. Blackhull exceeded Kharkof at 2 out of 5 stations and Kanred at 6 out of 9 stations. Kanred exceeded Kharkof more often and by a greater amount than any other variety. Karmont exceeded Kharkof at the two stations where they have been compared. This is a selection of Kharkof, C. I. No. 1583, which strain has exceeded the standard Kharkof, C. I. No. 1442, at 3 of the 7 stations where both were grown. Two other strains of Kharkof, i. e., Montana No. 36 and "Hays No. 2," also have yielded well, exceeding the standard, at least at one station.

The strains P–1066 and P–1068, which are very similar to Kanred, exceeded Kharkof at the Hays, Kans., station, where they were compared. Of the several strains of Turkey tested, C. I. No. 1571 in general has proved the best yielder, having exceeded Kharkof at 4 out of 10 stations.

The yields of most varieties and strains of hard red winter wheat have been very similar, and with the exception of Kanred few can be said definitely to be significantly better than the others. There are some, however, which have been found significantly poorer in yield than the standard Kharkof or the better strains previously listed. Very few varieties of soft red winter or white winter wheat have outyielded the leading hard red winter varieties in the dry-land areas covered by these investigations.

DAYS FROM EMERGENCE TO MATURITY

Notes on the dates of emergence and maturity of the varieties of wheat have been recorded each year at most of the field stations. The ripening of wheat in the Great Plains and Great Basin areas occurs prematurely in most of the seasons, owing to drought or hot winds. In moderately unfavorable seasons the period from emergence to maturity is shorter and the difference in the time of maturity between early and late varieties is less than for the same varieties in a normal ripening season, such as usually occurs in the subhumid

and humid areas. In very unfavorable seasons, hot winds ripen, or rather "deaden," all varieties of wheat at almost the same time, regardless of their relative normal periods of development. Thus, there is a wide variation in the time of maturity of the same variety of wheat in different seasons, due to environmental conditions at both the seeding and ripening periods.

In many seasons the wheat did not emerge until late in the fall, and the period from emergence to maturity thus was shortened. During five station years the winter wheat did not emerge until spring, but still produced a crop. The data from these five years are not included in the tables here presented. The average number of days from emergence to maturity of all varieties for which data for three or more years are available are presented in comparison with Kharkof in Table 19.

Satisfactory data on the number of days from emergence to maturity were obtained for the Kharkof variety during 89 station years. The average length of the period between emergence and maturity of Kharkof was 286.2 days. This period varied from 187 days at Lind, Wash., in 1918, to 354 days at Moccasin, Mont., in 1913. When Kharkof did not emerge until spring the period from emergence to maturity has varied from 106 to 149 days.

TABLE 19.—*Average time from emergence to maturity of 86 varieties and strains of winter wheat grown at 15 experiment stations in the Great Plains and Great Basin areas during 3 or more of the 15 years from 1908 to 1922, inclusive, compared with that of the Kharkof variety for the same station years*

Class and variety	C. I. No.	Station years	Average time from emergence to maturity (days)			
			Variety named	Kharkof, same years	Difference in days	
					Earlier	Later
Hard red winter:						
Kharkof		89	286.2			
Alberta Red	2979	36	287.0	286.7		0.3
Altara (Kansas No. 2048)	5797	10	277.7	277.3		.4
Alton	1438	46	277.7	278.5		.4
Argentine	1569	11	256.1	255.7		.4
Armavir	1355	12	266.5	265.0		1.5
Armavir (selection)	1355–2–2	9	306.7	307.2	0.5	
Bacska	1562	7	278.9	278.0		.9
Banat	1560	4	276.0	277.3	1.3	
Beloglina	1543	35	301.3	301.4	.1	
Do	1544	9	288.8	288.3		.5
Do	1667	12	270.7	270.5		.2
Do	2239	15	253.3	252.9		.4
Blackhull	6251	12	267.6	268.8	1.2	
Bulgarian	2048	6	275.5	276.0	.5	
Crimean	1432	17	303.8	302.1		1.7
Do	1433	7	302.9	302.4		.5
Do	1435	14	305.3	303.4		1.9
Do	1436	29	281.1	281.3	.2	
Do	1437	40	287.8	287.4		.4
Do	1559	32	299.5	299.8	.3	
Defiance	6214	3	258.0	258.3	.3	
Eversole	3011	3	325.3	326.7	1.4	
Hungarian	2034	3	275.7	277.3	1.6	
Kanred	5146	38	273.7	274.8	1.1	
Karmont	6700	12	288.6	288.1		.5
Kharkof	1442	59	287.2			
Kharkof (Selection No. 6P2)	1442	9	258.9	258.8		.1
Do	1583	42	300.2	300.2		
Do	2193	3	319.3	319.7	.4	
Do	4207	20	286.0	286.0		
Kharkof (Hays No. 2)	6686	7	264.3	264.4	.1	
Malakof	2208	28	282.9	283.0	.1	

TABLE 19.—*Average time from emergence to maturity of 86 varieties and strains of winter wheat grown at 15 experiment stations in the Great Plains and Great Basin areas during 3 or more of the 15 years from 1908 to 1922, inclusive, compared with that of the Kharkof variety for the same station years*—Continued

Class and variety	C. I. No.	Station years	Average time from emergence to maturity (days)			
			Variety named	Kharkof, same years	Difference in days	
					Earlier	Later
Hard red winter—Continued.						
Minturki	6155	12	293.3	292.5		.8
Montana No. 36	5549	11	279.7	279.1		.6
Nebraska No. 60	6250	5	255.0	253.8		1.2
P–1066	5879	3	257.7	258.3	.6	
P–1068	5880	3	258.0	258.3	.3	
Pesterboden	1564	12	267.8	268.3	.5	
Red Russian	1532	13	311.7	311.2		.5
Red Winter	6213	5	290.8	288.6		2.2
Reliable	3699	3	325.3	326.7	1.2	
Rumanian	1662	3	276.3	277.3	1.0	
Serbian	1676	3	275.3	277.3	2.0	
Serbian (Selection No. 4–1–10)	1728	3	284.7	282.7		2.0
"Station Red"	6467	3	250.0	248.7		1.3
Tauranian	6202	5	258.2	258.6	.4	
Theiss	1561	19	271.8	271.8		
Torgova	1539	9	284.2	282.8		1.4
Turkey	1558	40	283.2	282.9		.3
Do	1571	62	286.9	287.1	.2	
Do	1756	8	269.8	270.1	.3	
Do	1783	3	278.0	277.3		.7
Do	2223	5	253.8	254.0	.2	
Do	2943	8	290.0	289.1		.9
Do	2998	32	279.6	279.9	.3	
Do	3055	13	289.7	290.3	.6	
Do	3084	9	326.6	325.9		.7
Do	3689	4	294.8	294.8		
Do	4429	9	246.6	246.4		.2
Turkey (Washington No. 326)	6175	3	204.3	204.3		
Turkey (Renner)		5	257.4	257.6	.2	
Turkey (Blender)		3	257.3	257.3		
Turkey (Nygard)		4	284.0	284.0		
Turkey (Pioneer)		5	258.4	258.6	.2	
Ulta	1439	3	277.0	277.3	.3	
Weissenberg	1563	11	283.7	282.6		1.1
Soft red winter:						
Buffum No. 17	3330	31	302.8	298.7		4.1
Currell	2906	4	287.3	286.0		1.3
Diehl-Mediterranean	1395	8	295.0	295.3	.3	
Do	1395–2	7	257.3	255.0		2.3
Jones Fife	4468	3	270.0	269.0		1.0
Jones Fife (Super)	5544	5	247.2	246.8		.4
Jones Fife	6177	3	204.3	204.7	.4	
Lofthouse	3275	3	285.7	282.3		3.4
Minhardi	5149	7	296.9	294.6		2.3
Nebraska No. 28	5147	14	263.9	268.6	4.7	
Odessa	3274	3	266.7	265.3		1.4
Triplet	5408	8	228.3	228.3		
Zimmerman	2907	5	274.6	277.4	2.8	
White:						
Goldcoin (Fortyfold)	2996	7	269.3	267.4		1.9
Do	4156	6	243.2	240.8		2.4
Do	6176	3	206.3	204.7		1.6
Kofod	2997	9	283.8	279.2		4.6
Prohibition	4068	5	264.2	262.6		1.6
Club:						
Hybrid 128	4512	8	232.6	228.3		4.3

With the exception of 16 varieties, all of the hard red winter wheats have matured within one day of Kharkof, on the average. Data for 10 of these varieties were obtained during only 3, 4, or 5 station years. Five varieties of hard red winter wheat, viz, Armavir (C. I. No. 1355), Crimean (C. I. No. 1432), Crimean (C. I. No. 1435), Torgova, and Weissenberg, appear to be rather definitely later than Kharkof. Other varieties are somewhat earlier or later

in some years but on the average mature at almost the same time as Kharkof. It should be noted that Turkey, C. I. No. 1558, in 40 station years matured only 0.3 of a day later than Kharkof, while another commercial lot of Turkey, C. I. No. 1571, matured 0.2 of a day earlier than Kharkof, indicating that the two varieties are practically identical in this character.

A few varieties, including Blackhull and Kanred, are definitely earlier than Kharkof. Kanred in 38 station years was 1.1 days earlier than Kharkof.

Among the soft red winter wheats, Buffum No. 17, Lofthouse, Minhardi, and Odessa are distinctly later than Kharkof. The winter varieties of white wheat and club wheat grown in these experiments also are from one to five days later than Kharkof on the average.

WINTER SURVIVAL

Winterkilling is an important limiting factor in winter wheat production in the Great Plains area, especially in the Northern States. The winterkilling of wheat sometimes occurs in the Great Basin area, although hard red winter wheats usually are not injured by the low temperatures there. Winterkilling in the semiarid Western States usually is due to a combination of low temperatures, deficient moisture, soil blowing, soil heaving, ice covering, and possibly other factors. During the period of the experiments reported in this bulletin all of the winter wheat varieties were completely winterkilled at Williston, N. Dak., in 1912 and 1917; at Dickinson, N. Dak., in 1918 and 1920; at Moccasin, Mont., in 1916 and 1917; at Newell, S. Dak., in 1918; and at Akron, Colo., in 1909. When all varieties were killed the results are not used in computing the relative survival of the varieties. When no winterkilling occurred the relative hardiness can not be determined, and the data are not used in computing comparative hardiness. Estimates of the winter survival were made either by observation or by counting the stand in small areas in the plats. The percentage of winter survival was not reported in many experiments. Data on the relative survival of the winter-wheat varieties were recorded during 40 station years at the stations in the Great Plains area. Survival data also were recorded during five station years at three stations in the Great Basin area, but the behavior of some of the more tender varieties indicated that the differences in the extent of winterkilling were not due principally to differences in hardiness. The average percentage of winter survival of the varieties is shown in Table 20. The average survival of the standard Kharkof during 38 station years in which partial winterkilling occurred was 64.3 per cent. Most of the hard red winter varieties were less hardy than Kharkof. Those showing the greatest hardiness compared with Kharkof during five or more station years are Turkey (C. I. No. 3084), Kharkof (C. I. No. 4207), Minturki, Karmont, and Beloglina. In these experiments Kanred was slightly less hardy than Kharkof, while Blackhull shows an average survival of 10 per cent less than Kharkof.

Two varieties of soft red winter wheat, Diehl-Mediterranean and Nebraska No. 28, are distinctly less hardy than Kharkof, while two other varieties, Buffum No. 17 and Minhardi, are among the most hardy varieties of winter wheat grown in these experiments.

TABLE 20.—*Average winter survival of 38 varieties and strains of winter wheat grown at eight experiment stations in the Great Plains area during three or more years in which partial winterkilling occurred in the 15-year period from 1908 to 1922, inclusive, compared with that of the Kharkof variety for the same station years*

Class and variety	C. I. No.	Station years	Winter survival (per cent)			
			Variety named	Kharkof, same years	Difference	
					Less	Greater
Hard red winter:						
Kharkof		38	64.3			
Alberta Red	2979	11	61.3	70.0	8.3	
Altara	5797	4	63.8	59.3		4.5
Alton	1438	16	68.6	72.4	3.8	
Armavir (selection)	1355-2-2	8	55.6	63.3	7.7	
Beloglina	1543	22	60.4	59.0		1.4
Do	1667	3	62.3	59.7		2.6
Blackhull	6251	5	42.8	52.8	10.0	
Crimean	1432	9	65.3	64.2		1.1
Do	1435	3	70.0	68.0		2.0
Do	1436	8	80.8	83.0	2.2	
Do	1437	15	73.8	73.7		.1
Do	1559	14	68.5	72.1	3.6	
Eversole	3011	3	24.7	27.3	2.6	
Kanred	5146	16	62.7	64.2	1.5	
Karmont	6700	8	65.5	61.8		3.7
Kharkof	1442	21	69.8			
Kharkof (selection No. 6P2)	1442	3	92.0	92.0		
Kharkof	1583	21	69.3	69.8	.5	
Do	4207	8	82.1	76.8		5.3
Malakof	2208	12	70.4	74.1	3.7	
Minturki	6155	8	59.3	55.4		3.9
Montana No. 36	5549	6	66.3	70.0	3.7	
Red Russian	1532	9	60.8	64.2	3.4	
Serbian (selection No. 4-1-10)	1728	3	68.3	76.7	8.4	
Theiss	1561	5	58.0	57.8		.2
Torgova	1539	3	79.0	78.3		.7
Turkey	1558	12	59.2	62.5	3.3	
Do	1571	28	64.9	67.9	3.0	
Do	2943	4	63.8	69.3	5.8	
Do	2998	10	69.3	70.5	1.2	
Do	3055	6	62.2	59.7		2.5
Do	3084	9	61.7	50.0		11.7
Turkey (Grafton)	3696	3	36.0	27.3		8.7
Soft red winter:						
Buffum No. 17	3330	19	75.2	64.0		11.2
Diehl-Mediterranean	1395	5	69.8	73.8	4.0	
Minhardi	5149	6	65.7	54.8		10.9
Nebraska No. 28	5147	5	63.8	74.6	10.8	

STEM-RUST INFECTION

Stem rust (*Puccinia graminis tritici*) is of common occurrence in the northern half of the Great Plains area. Fortunately, however, this disease usually is limited to the eastern portion of this section. In 1916 and 1919 very severe epidemics occurred. Some damage from rust occurs at a few of the stations nearly every year. In the southern half of the Great Plains area stem rust sometimes occurs but is not an important factor in affecting the yields of winter wheat. Stem rust rarely occurs in the Great Basin and has not affected the yields of wheat reported in this bulletin. Stripe rust, which does occur there, causes very little injury. Winter wheat usually matures earlier and is better able to escape rust than spring wheat. When rust occurs on the varieties grown at field stations the percentage of infection usually is recorded. This is estimated by examining the wheat plants and comparing them with the standard scale shown in Figure 3. On this scale 100 per cent infection means that 37 per cent of the surface of the culms is covered by rust pustules.

An infection of 10 per cent or more usually is sufficient to cause a noticeable reduction in yield, while 100 per cent infection of black stem rust often results in a total failure of the crop. The quality of the wheat also is injured by rust.

Data on stem-rust infection have been obtained during two years at each of six stations, or in a total of 12 station years. Stem rust was recorded in 1914 at Akron, Colo.; in 1915 at Newell, S. Dak., and Archer, Wyo.; in 1916 at Highmore and Newell, S. Dak., and Hays, Kans.; in 1919 at Highmore, S. Dak.; in 1920 at Akron, Colo., and Archer, Wyo.; in 1921 at Dickinson, N. Dak.; and in 1922 at Dickinson, N. Dak., and Hays, Kans. Stem rust has not occurred at Moccasin, Mont., during the 15 years from 1908 to 1922.

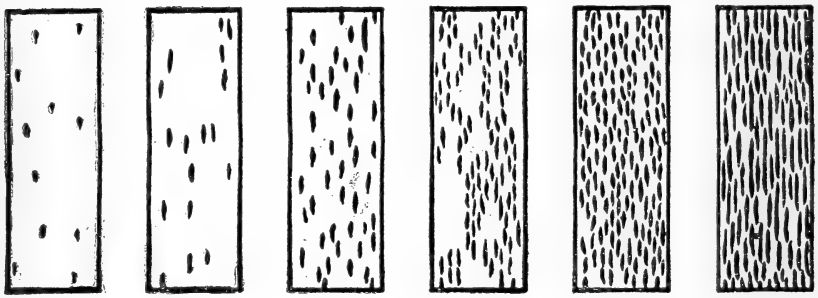

FIG. 3.—Scale for estimating rust, illustrating six degrees of rustiness used in estimating the percentage of stem-rust infection. The shaded spots represent rust, and the figures represent approximately the rust percentages computed on the basis of the maximum of surface covered by rust as shown in the 100 per cent figure (F). Figure F in the diagram represents 37 per cent of actual rust-covered surface and is arbitrarily selected as 100 per cent. The other percentages are in terms of Figure F.

TABLE 21.—*Stem-rust infection of 23 varieties and strains of winter wheat grown at six experiment stations in the Great Plains area during three or more years in which rust occurred in the 9-year period from 1914 to 1922, inclusive, compared with that of the Kharkof variety for the same station years*

Class and variety	C. I. No.	Station years	Average stem-rust infection (per cent)			
			Variety named	Kharkof, same years	Difference	
					Less	Greater
Hard red winter:						
Kharkof		12	9.2			
Alberta Red	2979	4	11.5	12.3	0.8	
Altara	5797	3	15.7	19.7	4.0	
Alton	1438	6	15.0	13.8		1.2
Armavir (selection)	1355–2–2	3	10.7	16.7	6.0	
Beloglina	1543	5	8.4	7.4		1.0
Blackhull	6251	3	24.0	19.7		4.3
Crimean	1436	4	9.5	11.3	1.8	
Do	1559	3	7.3	9.0	1.7	
Kanred	5146	7	4.0	10.0	6.0	
Karmont	6700	3	3.7	3.7		
Kharkof	1442	8	11.1			
Do	1583	10	9.6	9.0		.6
Do	4207	6	14.0	10.5		3.5
Malakof	2208	4	11.5	11.5		
Minturki	6155	5	14.0	12.0		2.0
Theiss	1561	4	12.5	9.5		3.0
Turkey	1558	5	13.0	9.6		3.4
Do	1571	9	10.4	9.4		1.0
Do	2943	4	11.5	9.5		2.0
Do	3055	4	12.5	9.5		3.0
Soft red winter:						
Buffum No. 17	3330	7	7.1	6.1		1.0
Minhardi	5149	3	11.7	3.7		8.0
Nebraska No. 28	5147	3	10.0	13.0	3.0	

The average percentages of stem-rust infection on 23 varieties of wheat in comparison with Kharkof are shown in Table 21. Kharkof wheat shows an average stem-rust infection of 9.2 per cent in 12 station years, during which the degrees of rust infection varied from 0 to 25 per cent in different years. Most of the hard red winter varieties did not differ greatly from Kharkof in average rust infection. Kanred during seven station years showed an average infection of 6 per cent less than Kharkof. Less than five observations were made on the other varieties which had less rust than Kharkof. Kanred apparently is the most rust-resistant wheat grown in these experiments.

Of the soft red winter wheats, Buffum No. 17 showed only a slightly higher rust infection than Kharkof, while Minhardi in three station years showed an infection 8 per cent higher. Nebraska No. 28, because of its earliness, is able to escape rust better than Kharkof.

HEIGHT OF PLANT

The height of the wheat plant is of economic importance because it determines the method or ease of harvesting. The height of different varieties of wheat, as measured from the surface of the ground to the tip of the spike, has varied considerably in these experiments. The average height of Kharkof wheat during 106 station years in these semiarid areas is 30.3 inches, but its stature has varied from 16 to 46 inches. The height of Kharkof wheat at Moccasin, Mont., was 46 inches in 1915, but only 17 inches in 1919. The height of the wheat plant is determined by the amount of elongation of the internodes of the culm and is influenced by numerous soil and climatic factors. In the Great Plains and Great Basin the height is affected chiefly by the climate, including the soil moisture which is the result of the annual precipitation. The height of the wheat plant is increased by high soil fertility, abundant moisture, humid atmosphere, moderately cool temperature, and other factors which favor vegetative growth at the time of heading. In general, early varieties are shorter than late varieties. Late varieties which are normally quite tall are sometimes shorter than short early varieties in seasons having drought or hot winds at heading time. When the drought, temperatures, or hot winds are extreme, the heads of wheat may not be entirely exerted from the sheath.

The average plant heights of the varieties of winter wheat grown during three or more station years in comparison with Kharkof are shown in Table 22.

The average heights of the hard red winter varieties shown in Table 22 indicate that they do not differ greatly from Kharkof. Such varieties as Bacska, Banat, Hungarian, and Pesterboden differ from Kharkof in the size of the spikes and kernels as well as in height. The Blackhull variety averaged 1.3 inches taller than Kharkof. Two strains of Crimean, C. I. Nos. 1433 and 1435, as well as Rieti and Ulta, appear to be somewhat taller than Kharkof. Other varieties having average heights more than 1 inch taller than Kharkof were grown only during limited periods. In general, those of the hard red winter wheats which can not be distinguished otherwise from Turkey and Kharkof are practically the same height as those varieties. Turkey (C. I. No. 1571) in 73 station years averaged 0.1 inch shorter than Kharkof.

All of the soft red winter varieties except Nebraska No. 28 and Triplet and all of the white wheats except Genesee Giant are taller than Kharkof. Two identical lots of Hybrid 128, a winter club wheat, indicate that the variety is about the same height as Kharkof, as one lot averaged taller and the other shorter.

TABLE 22.—*Average height of plant of 112 varieties and strains of winter wheat grown at one or more of the 15 experiment stations in the Great Plains and Great Basin areas during three or more station years in the 15-year period from 1908 to 1922, inclusive, compared with that of the Kharkof variety in the same station years*

Class and variety	C. I. No.	Station years	Average height (inches)			
			Variety named	Kharkof, same years	Difference	
					Shorter	Taller
Hard red winter:						
Kharkof		106	30.3			
Alberta Red	2979	50	29.9	30.3	0.4	
Altara (Kansas No. 2048)	5797	10	32.8	33.0	.2	
Alton	1438	62	30.0	29.0		1.0
Argentine	1569	16	27.1	27.1		
Armavir	1355	23	29.5	28.9		.6
Armavir (selection)	1355–2–2	9	30.0	29.1		.9
Bacska	1562	16	31.0	29.8		1.2
Banat	1560	10	30.9	29.3		1.6
Beloglina	1543	43	29.7	29.8	.1	
Do	1544	15	28.3	29.3	1.0	
Do	1549	4	26.8	25.4		1.4
Do	1667	17	27.5	27.6	.1	
Do	2239	19	27.6	28.4	.8	
Blackhull	6251	16	33.4	32.1		1.3
Bosnian	1691	4	26.3	26.3		
Budapest	1739	5	26.2	25.8		.4
Bulgarian	2048	15	28.5	27.5		1.0
Crimean	1432	25	28.7	29.0	.3	
Do	1433	13	30.5	29.0		1.5
Do	1435	21	32.9	31.7		1.2
Do	1436	37	32.4	31.9		.5
Do	1437	53	29.9	29.9		
Do	1559	43	30.0	30.3	.3	
Defiance	6214	4	36.8	36.3		.5
Eversole	3011	4	29.0	29.5	.5	
Hungarian	2034	8	29.8	28.0		1.8
Do	2042	4	27.3	26.3		1.0
Kanred	5146	45	30.2	29.7		.5
Karmont	6700	13	31.8	31.6		.2
Kharkof	1442	76	30.1			
Kharkof (No. 6P2)	1442	10	33.8	33.1		.7
Kharkof	1583	51	31.8	31.8		
Do	4207	21	32.9	33.1	.2	
Do	5293	3	25.7	23.0		2.7
Kharkof (Hays No. 2)	6686	8	34.0	34.1	.1	
Malakof	2208	39	30.0	29.9		.1
Minturki	6155	15	34.4	33.4		1.0
Montana No. 36	5549	12	28.8	29.2	.4	
Nebraska No. 6	6249	4	37.8	38.0	.2	
Nebraska No. 60	6250	7	33.7	34.1	.4	
P–1066	5879	4	37.3	36.3		1.0
P–1068	5880	4	36.0	36.3	.3	
Pesterboden	1564	22	30.5	29.0		1.5
Red Russian	1532	19	30.6	29.8		.8
Red Winter	6213	3	35.7	35.0		.7
Reliable	3699	3	27.0	26.3		.7
Rieti	2942	6	31.0	28.7		2.3
Rumanian (No. 237)		3	35.0	34.7		.3
Rumanian	1656	6	25.8	25.7		.1
Do	1658	4	26.3	26.3		
Do	1662	7	28.6	28.9	.3	
Serbian	1676	9	30.3	28.1		2.2
Serbian (Selection No. 4–1–10)	1728	3	27.3	27.0		.3
"Station Red"	6467	5	30.2	29.6		.6
Tauranian	6202	5	33.4	33.2		.2
Theiss	1561	28	30.5	30.4		.1
Torgova	1539	16	30.7	30.7		

TABLE 22.—*Average height of plant of 112 varieties and strains of winter wheat grown at one or more of the 15 experiment stations in the Great Plains and Great Basin areas during three or more station years in the 15-year period from 1908 to 1922, inclusive, compared with that of the Kharkof variety in the same station years*—Continued

Class and variety	C. I. No.	Station years	Average height (inches)			
			Variety named	Kharkof, same years	Difference	
					Shorter	Taller
Hard red winter—Continued.						
Turkey	1558	50	31.4	31.2		0.2
Do	1571	73	30.2	30.3	0.1	
Do	1756	17	29.0	28.6		.4
Do	1783	9	27.9	27.6		.3
Do	1784	3	28.7	27.0		1.7
Do	2223	6	26.2	24.8		1.4
Do	2943	8	34.4	35.6	1.2	
Do	2998	46	28.5	28.9	.4	
Do	3055	18	31.2	31.8	.6	
Do	3084	9	31.9	30.0		1.9
Do	3689	4	35.0	38.0	3.0	
Do	4061	4	26.3	25.5		.8
Do	4429	10	28.6	30.3	1.7	
Turkey (Improved)	5592	3	38.3	38.0		.3
Turkey (Washington No. 326)	6175	4	21.8	21.3		.5
Turkey (Kansas No. 1664)	6472	3	38.3	38.3		
Turkey (Renner)		5	33.2	33.6	.4	
Turkey (Blender)		3	30.0	30.0		
Turkey (Nygard)		4	34.0	34.0		
Turkey (Pioneer)		6	35.2	34.2		1.0
Turkey (Grafton)	3696	3	30.3	31.3	1.0	
Ulta	1439	8	29.9	28.6		1.3
Weissenberg	1563	21	30.5	30.0		.5
Soft red winter:						
Buffum No. 17	3330	33	32.9	30.4		2.5
Currell	2906	10	32.5	29.9		2.6
Diehl-Mediterranean	1395	10	29.5	27.9		1.6
Do	1395–2	10	29.3	26.7		2.6
Dietz		3	28.7	27.3		1.4
Fulcaster		3	41.7	38.3		3.4
Fultz	6215	4	33.0	31.5		1.5
Harvest Queen	6199	3	43.0	38.3		4.7
Japanese	1787	8	31.8	27.3		4.5
Japanese Squarehead	1788–1	4	28.0	26.3		1.7
Jones Fife	4468	3	34.0	31.7		2.3
Jones Fife (Super)	5544	6	29.0	26.7		2.3
Jones Fife	6177	4	23.5	21.3		2.2
Lofthouse	3275	7	29.4	28.1		1.3
Mammoth Red	2902	4	29.5	29.3		.2
Minhardi	5149	10	34.3	32.8		1.5
Nebraska No. 28	5147	21	29.4	29.9	.5	
Odessa	3274	7	26.9	25.9		1.0
Purplestraw	1915	3	38.3	32.3		6.0
Penquite (Japanese Velvet Chaff)	1757	4	28.5	26.3		2.2
Triplet	5408	11	26.2	26.2		
Zimmerman	2907	9	33.8	30.2		3.6
White:						
Genesee Giant		3	27.0	27.3	.3	
Goldcoin (Fortyfold)	2996	17	27.6	26.5		1.1
Do	6176	4	22.8	21.3		1.5
Do	4156	8	31.6	30.0		1.6
Do	5290	3	33.3	31.0		2.3
Kofod	2997	18	29.8	28.8		1.0
Prohibition	4068	6	33.5	29.3		4.2
Winter Bluestem	5409	3	23.0	21.3		1.7
Club:						
Hybrid 128	4326	4	23.3	24.5	1.2	
Do	4512	10	28.3	27.3		1.0

TEST WEIGHT PER BUSHEL

The test weight per bushel of all varieties of wheat at the 15 stations has been determined nearly every year by the use of the standard test kettle. Most of the tests were made on the wheat after it had been cleaned with a fanning mill. The weights have varied according to

seasonal conditions. Drought, hot winds, lodging, and occasionally rust resulted in shrunken kernels during many of the years. The average bushel weights of the varieties of winter wheat upon which three or more tests have been made are shown in Table 23.

Kharkof had an average test weight per bushel of 58.6 pounds during 102 station years, the weights varying from 46 to 63 pounds per bushel. It will be seen that Kharkof has a heavier test weight than nearly all other varieties. Only two varieties exceeded Kharkof in bushel weight by more than 1 pound, and only three and four tests, respectively, were made on these varieties. Altara, Blackhull, Kharkof (C. I. No. 4207), Nebraska No. 60, Turkey (C. I. No. 3055), and Pioneer Turkey tested 0.5 pound per bushel higher than Kharkof during six or more station years, probably due to better local adaptation and better development of the kernels.

All varieties of soft red winter wheat, white wheat, and club wheat had a lower test weight in these experiments than the standard Kharkof variety.

TABLE 23.—*Average test weight per bushel of 110 varieties and strains of winter wheat grown at 15 experiment stations in the Great Plains and Great Basin areas during 3 or more of the 15 years from 1908 to 1922, inclusive, compared with that of the Kharkof variety in the same station years*

Class and variety	C. I. No.	Station years	Average test weight per bushel (pounds)			
			Variety named	Kharkof, same years	Difference	
					Lighter	Heavier
Hard red winter:						
Kharkof		102	58.6			
Alberta Red	2979	49	59.6	59.7	0.1	
Altara (Kansas No. 2048)	5797	11	58.3	57.8		0.5
Alton	1438	57	58.8	59.2	.4	
Argentine	1569	14	58.7	59.0	.3	
Armavir	1355	22	59.8	60.0	.2	
Armavir (selection)	1355-2-2	9	57.7	58.3	.6	
Bacska	1562	15	59.3	60.8	1.5	
Banat	1560	9	60.1	60.7	.6	
Beloglina	1543	37	58.1	59.1	1.0	
Do	1544	14	59.3	60.1	.8	
Do	1549	4	57.8	59.9	2.1	
Do	1667	19	58.4	58.9	.5	
Do	2239	21	57.5	58.7	1.2	
Blackhull	6251	16	59.0	58.3		.7
Bosnian	1691	4	59.8	61.3	1.5	
Budapest	1739	5	59.4	61.4	2.0	
Bulgarian	2048	13	60.6	60.9	.3	
Crimean	1432	24	59.7	59.7		
Do	1433	12	58.3	60.2	1.9	
Do	1435	22	59.4	60.3	.9	
Do	1436	39	58.0	58.8	.8	
Do	1437	53	59.4	59.5	.1	
Do	1559	37	59.8	59.6		.2
Defiance	6214	4	55.8	56.3	.5	
Eversole	3011	4	59.8	60.0	.2	
Hungarian	2034	8	60.0	61.4	1.4	
Do	2042	4	59.3	61.3	2.0	
Kanred	5146	43	57.8	57.5		.3
Karmont	6700	13	58.9	59.3	.4	
Kharkof	1442	70	59.0			
Kharkof (selection No. 6P2)	1442	10	56.3	56.6	.3	
Kharkof	1583	51	58.9	58.7		.2
Do	2193	3	59.5	59.2		.3
Do	4207	20	57.8	57.3		.5
Do	5293	3	56.7	55.3		1.4
Kharkof (Hays No. 2)	6686	8	55.8	56.1	.3	
Malakof	2208	35	58.7	59.0	.3	
Minturki	6155	15	57.4	58.5	1.1	
Montana No. 36	5549	13	58.2	58.4	.2	
Nebraska No. 6	6249	4	56.8	57.0	.2	
Nebraska No. 60	6250	7	58.6	58.1		.5

TABLE 23.—*Average test weight per bushel of 110 varieties and strains of winter wheat grown at 15 experiment stations in the Great Plains and Great Basin areas during 3 or more of the 15 years from 1908 to 1922, inclusive, compared with that of the Kharkof variety in the same station years*—Continued

Class and variety	C. I. No.	Station years	Average test weight per bushel (pounds)			
			Variety named	Kharkof, same years	Difference	
					Lighter	Heavier
Hard red winter—Continued.						
P–1066	5879	4	56.5	56.3		0.2
P–1068	5880	4	56.0	56.3	0.3	
Pesterboden	1564	22	58.3	59.5	1.2	
Red Russian	1532	18	58.5	59.8	1.3	
Red Winter	6213	5	56.4	58.4	2.0	
Reliable	3699	3	59.2	59.8	.6	
Rieti	2942	7	56.9	59.3	2.4	
Rumanian (No. 237)		3	54.7	55.2	.5	
Rumanian	1656	6	59.6	61.2	1.6	
Do	1658	4	58.9	61.3	2.4	
Do	1662	7	60.7	61.6	.9	
Serbian	1676	8	60.4	61.4	1.0	
Serbian (selection No. 4–1–10)	1728	3	59.2	59.3	.1	
"Station Red"	6467	5	60.3	59.6		.7
Tauranian	6202	5	54.2	54.0		.2
Theiss	1561	29	58.5	58.6	.1	
Torgova	1539	14	57.7	59.3	1.6	
Turkey	1558	49	58.9	58.7		.2
Do	1571	69	58.7	58.8	.1	
Do	1756	17	59.4	60.6	1.2	
Do	1783	9	61.4	61.4		
Do	1784	3	55.7	60.7	5.0	
Do	2223	6	56.5	56.8	.3	
Do	2943	10	55.8	56.2	.4	
Do	2998	43	59.0	59.3	.3	
Do	3055	18	59.1	58.4		.7
Do	3084	9	57.7	58.6	.9	
Do	3689	4	55.8	51.5		4.3
Do	4061	4	60.3	59.9		.4
Do	4429	9	58.4	58.9	.5	
Turkey (Improved)	5592	3	59.0	58.3		.7
Turkey (Washington No. 326)	6175	4	57.9	57.6		.3
Turkey (Kansas No. 1664)	6472	3	59.7	58.3		1.4
Turkey (Blender)		3	51.2	51.3	.1	
Turkey (Grafton)	3696	3	59.8	59.7		.1
Turkey (Nygard)		4	53.1	52.8		.3
Turkey (Pioneer)		6	55.3	54.8		.5
Turkey (Renner)		7	54.9	55.1	.2	
Ulta	1439	7	60.6	61.4	.8	
Weissenberg	1563	20	59.4	60.4	1.0	
Soft red winter:						
Buffum No. 17	3330	30	55.9	58.1	2.2	
Currell	2906	10	57.9	60.8	2.9	
Diehl-Mediterranean	1395	8	58.4	58.6	.2	
Do	1395–2	13	57.1	58.8	1.7	
Dietz		3	59.7	61.0	1.3	
Fultz	6215	4	60.1	61.3	1.2	
Harvest Queen	6199	3	57.2	58.3	1.1	
Japanese	1787	7	59.0	61.3	2.3	
Japanese Squarehead	1788–1	4	57.9	61.3	3.4	
Jones Fife	4468	3	58.7	60.7	2.0	
Jones Fife (Super)	5544	6	56.3	59.5	3.2	
Jones Fife	6177	4	55.3	57.6	2.3	
Lofthouse	3275	7	57.7	61.1	3.4	
Mammoth Red	2902	6	58.3	59.9	1.6	
Minhardi	5149	11	57.7	59.5	1.6	
Nebraska No. 28	5147	19	55.6	55.9	.3	
Odessa	3274	6	58.0	60.5	2.5	
Penquite (Japanese Velvet Chaff)	1757	4	56.3	61.3	5.0	
Triplet	5408	11	57.5	58.6	1.1	
Zimmerman	2907	8	57.6	60.1	2.5	
White:						
Genesee Giant		3	58.7	61.0	2.3	
Goldcoin (Fortyfold)	2996	16	58.1	59.9	1.8	
Do	4156	7	57.0	58.5	1.5	
Do	6176	4	55.0	57.6	2.6	
Kofod	2997	15	58.0	60.3	2.3	
Prohibition	4068	4	58.0	58.3	.3	
Winter Bluestem	5409	3	55.0	57.3	2.3	
Club:						
Hybrid 128	4326	4	56.8	59.5	2.7	
Do	4512	9	55.7	58.8	1.1	

CRUDE-PROTEIN CONTENT

Samples of several of the more important winter wheats have been analyzed for crude-protein content and have been milled and baked in the experimental mill of the United States Department of Agriculture. The milling and baking experiments were conducted in cooperation with the Milling Investigations Section of the Grain Division of the Bureau of Agricultural Economics. Complete data regarding the wheat, flour, and bread from each lot of wheat tested have been obtained, but data on only three important factors are presented here. The average results shown are from varieties grown during three or more station years.

Each sample of wheat is analyzed for nitrogen. The percentage of crude protein is the percentage of nitrogen multiplied by the factor 5.7. The result is then computed to a standard basis of 13.5 per cent moisture in the wheat, as the samples vary somewhat in moisture content. The protein content of wheat is an indication of the strength of the flour and of the gluten content. The average percentages of protein in 14 varieties of hard red winter wheat, compared with those of Kharkof during the same station years, are shown in Table 24.

TABLE 24.—*Crude-protein content in 14 varieties and strains of hard red winter wheat grown at 14 experiment stations in the Great Plains and Great Basin areas during three or more of the eight years from 1915 to 1922, inclusive, compared with that of the Kharkof variety in the same station years*

[Data obtained in cooperation with the Research Laboratory, Grain Division, Bureau of Agricultural Economics]

Class and variety	C. I. No.	Station years	Crude-protein content (per cent) [1]			
			Variety named	Kharkof, same years	Difference	
					Less	Greater
Altara	5797	5	14.1	14.9	0.8	
Alton	1438	8	15.5	15.9	.4	
Beloglina	1543	3	14.8	14.2		0.6
Blackhull	6251	13	13.8	14.0	.2	
Kanred	5146	25	14.7	14.8	.1	
Karmont	6700	11	14.7	14.7		
Kharkof	1442	54	14.5			
Do	1583	3	14.4	14.2		.2
Kharkof (Hays No. 2)	6686	3	15.5	15.2		.3
Minturki	6155	9	15.0	14.8		.2
Montana No. 36	5549	6	15.3	14.8		.5
Nebraska No. 60	6250	4	14.2	13.7		.5
Turkey	1558	8	14.3	14.4	.1	
Do	1571	7	15.2	14.7		.5
Do	3689	3	13.3	13.2		.1

[1] Crude protein equals nitrogen × 5.7 computed to a basis of 13.5 per cent moisture in the wheat.

Kharkof wheat has had an average protein content of 14.5 per cent from 54 samples representing as many station years. Most of the hard red winter wheats have about the same protein content as Kharkof. Altara and Alton have comparatively less protein. Beloglina, Montana No. 36, Nebraska No. 60, and Turkey (C. I. No. 1571) have been found to have somewhat higher percentages of protein than Kharkof.

YIELD OF FLOUR

Samples containing about 1,500 grams of wheat are ground in a series of small roller mills to determine the percentage of flour. The bran, shorts, and flour are separated by bolting. Only one grade, called straight flour, is separated in the experimental milling. The flour obtained is weighed, and the percentage is determined from the quantity of wheat milled. The flour yield of a wheat sample depends largely on the bushel weight or plumpness of the kernel. There is a wide difference in flour yield from varieties grown under different conditions, due to the seasonal effect on the plumpness of the kernel. Different varieties, however, may produce significantly low or high average percentages of flour when grown under the same conditions. Flour yields of 14 varieties of hard red winter wheat grown in the experiments reported in this bulletin are shown in Table 25.

TABLE 25.—*Flour obtained from milling 14 varieties and strains of hard red winter wheat grown at 14 experiment stations in the Great Plains and Great Basin areas during three or more of the eight years from 1915 to 1922, inclusive, compared with that from the Kharkof variety in the same station years*

[Data obtained in cooperation with the Milling Investigations Section, Grain Division, Bureau of Agricultural Economics]

Class and variety	C. I. No.	Station years	Yield of flour (per cent)			
			Variety named	Kharkof, same years	Difference	
					Less	Greater
Altara	5797	5	72.7	71.5		1.2
Alton	1438	8	76.0	74.4		1.6
Beloglina	1543	3	78.1	76.2		1.9
Blackhull	6251	13	71.7	72.7	1.0	
Kanred	5146	25	74.8	72.8		2.0
Karmont	6700	11	73.2	72.9		.3
Kharkof	1442	54	72.2			
Do	1583	3	73.1	74.5	1.4	
Kharkof (Hays No. 2)	6686	3	72.4	72.1		.3
Minturki	6155	9	71.4	73.0	1.6	
Montana No. 36	5549	6	74.1	73.7		.4
Nebraska No. 60	6250	4	70.4	70.7	.3	
Turkey	1558	8	72.7	72.5		.2
Do	1571	7	74.1	73.4		.7
Do	3689	3	72.4	71.7		.7

The average yield of flour obtained from 54 samples of Kharkof was 72.2 per cent. Most of the hard red winter wheats produced about the same yield of flour, except Minturki, which produced a distinctly lower percentage of flour, and Beloglina and Kanred, which were decidedly higher in flour yield.

VOLUME OF LOAF

Bread has been baked from flour of each variety of wheat milled. The bakings are made in duplicate, using the same flour on two successive days. All varieties are treated alike from the first mixing until the baking is completed, 340 grams of flour and equal quantities of all other ingredients except water being used for each variety. The volume of each loaf is measured and recorded in cubic centimeters. The average volume of the two loaves baked on successive days finally is recorded as the correct loaf volume for the sample.

The loaf volume is a good measure of the expansion or strength of the dough, the quantity and quality of gluten, and the resulting texture and lightness of the bread. The average volumes of loaves of bread baked from flour of 14 varieties of hard red winter wheat are shown in Table 26.

The average loaf volume of 54 samples of Kharkof was 2,052 cubic centimeters. Most of the other varieties of hard red winter wheat produced loaves having about the same volume as that of Kharkof. Alton, Blackhull, Kanred, Karmont, Montana No. 36, and Nebraska No. 60 all produced loaves of slightly lower volume, while Beloglina and Minturki produced distinctly larger loaves.

TABLE 26.—*Average volume of loaves of bread made from 14 varieties and strains of hard red winter wheat grown at 14 experiment stations in the Great Plains and Great Basin areas during three or more of the eight years from 1915 to 1922, inclusive, compared with that of the Kharkof variety in the same station years*

[Data obtained in cooperation with the Milling Investigations Section, Grain Division, Bureau of Agricultural Economics]

Class and variety	C. I. No.	Station years	Loaf volume (cubic centimeters)			
			Variety named	Kharkof, same years	Difference	
					Less	Greater
Altara	5797	5	2,008	1,932		76
Alton	1438	8	1,953	1,989	36	
Beloglina	1543	3	2,443	2,203		240
Blackhull	6251	13	1,931	1,982	51	
Kanred	5146	25	1,990	2,039	49	
Karmont	6700	11	1,970	1,997	27	
Kharkof	1442	54	2,052			
Do	1583	3	2,013	2,003		10
Kharkof (Hays No. 2)	6686	3	2,000	1,973		27
Minturki	6155	9	2,246	2,013		233
Montana No. 36	5549	6	1,875	1,918	43	
Nebraska No. 60	6250	4	1,935	1,973	38	
Turkey	1558	8	2,071	2,078	7	
Do	1571	7	1,959	1,953		6
Do	3689	3	2,205	2,150		55

SUMMARY OF RESULTS

The normal or average annual precipitation at 10 field stations in the Great Plains has been between 14 and 23 inches and at 5 field stations in the Great Basin area between 7 and 14 inches. Drought, winterkilling, or disease have occurred in several of the years, frequently causing loss of the crop or early ripening and poor quality of the wheat.

Yields and other important agronomic data, such as height of plant, time of maturity, stem-rust infection, and test weight per bushel, are presented for no less than 110 varieties and strains of winter wheat which have been grown in plats. Samples of the more important varieties have been milled and bread baked from the flour.

Three classes of winter wheat have been grown and compared—hard red winter, soft red winter, and white, including common and club. The hard red winter wheats have consistently outyielded the other classes of winter wheat. About 85 varieties and strains of hard red winter wheat have been tested.

Strains of Kharkof were selected as the standard for comparison. This wheat was found to be equal or slightly superior to Turkey, the leading variety of hard red winter wheat, in yield, winter hardiness, and other agronomic characters and in milling and baking quality. Several strains of these or other hard red winter wheats are shown to have certain advantages over Kharkof and Turkey, but most of the varieties and strains tested are not superior to them.

Kanred, in general, was the most productive hard red winter wheat for the Great Plains area. Other high-yielding strains are Alberta Red, Argentine, Beloglina, Blackhull, Karmont, Montana No. 36, Nebraska No. 60, and Turkey (C. I. No. 1571).

Few strains or varieties were found to be distinctly earlier and taller than Kharkof. Blackhull exceeds most of the other varieties in these characters, which gives it a decided advantage in some sections.

In winter hardiness Minturki and in stem-rust resistance Kanred have exceeded most of the other varieties of hard red winter wheat.

For milling and baking value as determined from crude-protein content, yield of straight flour, and volume of loaf, the Beloglina, Kanred, and Minturki varieties have one or more distinct advantages over Kharkof and other hard red winter wheats.

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